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COMPARATIVE ANALYSIS OF UNITED STATES ARMY AND MARINE CORPS HUMAN SYSTEMS INTEGRATION METHODOLOGIES

by

Michael F. Belcher

March, 1995

Thesis Co-Advisors: Thomas H. Hoivik
Frank C. Petho

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13. ABSTRACT *(maximum 200 words)*

This thesis analyzes how the United States Army and Marine Corps comply with Department of Defense Directive 5000.2, "Defense Acquisition Management Policies and Procedures," which mandates the effective integration of human considerations into the acquisition process.

Despite a common purpose, the Army and Marine Corps human systems integration (HSI) programs have evolved distinctive policies, procedures, and methodologies, tailored to the Services' unique operational and organizational environments. To evaluate program effectiveness, this thesis performs a comparative analysis of the HSI procedures employed by each Service in the acquisition of major and non-major ground combat weapon systems. Specifically, the thesis constructs an HSI Attributes Matrix, contrasting the Advanced Amphibious Assault Vehicle (AAAV) with the Armored Gun System (AGS), and the Short Range Anti-tank Weapon (SRAW/Predator) with the Advanced Anti-tank Weapon System-Medium (AAWS-M/Javelin).

Extrapolating generalizations from case analyses, this thesis identifies the policies, procedures, and methodologies which are most effectual in integrating human considerations into system acquisition. Finally, the thesis recommends modifications to the Marine Corps' HSI program to improve the acquisition process and thereby, better satisfy the operational requirements of the Fleet Marine Force.

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COMPARATIVE ANALYSIS OF UNITED STATES ARMY AND MARINE CORPS HUMAN SYSTEMS INTEGRATION METHODOLOGIES

by

Michael F. Belcher
Captain, United States Marine Corps
B.A., University of Pennsylvania, 1983

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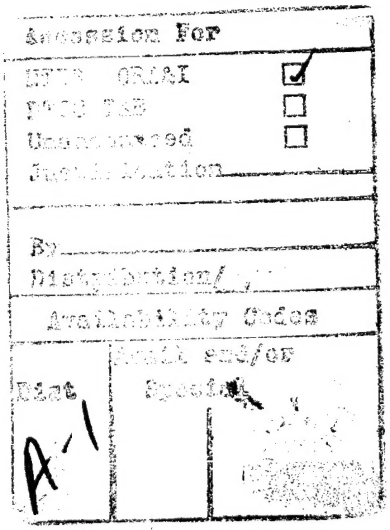
Author: _____
Michael F. Belcher

Approved by: _____
Thomas H. Hoivik, Thesis Co-Advisor

_____
Frank C. Petho, Thesis Co-Advisor

_____
David R. Whipple, Chairman
Department of Systems Management



ABSTRACT

This thesis analyzes how the United States Army and Marine Corps comply with Department of Defense Directive 5000.2, "Defense Acquisition Management Policies and Procedures," which mandates the effective integration of human considerations into the acquisition process.

Despite a common purpose, the Army and Marine Corps human systems integration (HSI) programs have evolved distinctive policies, procedures, and methodologies, tailored to the Services' unique operational and organizational environments. To evaluate program effectiveness, this thesis performs a comparative analysis of the HSI procedures employed by each Service in the acquisition of major and non-major ground combat weapon systems. Specifically, the thesis constructs an HSI Attributes Matrix, contrasting the Advanced Amphibious Assault Vehicle (AAAV) with the Armored Gun System (AGS), and the Short Range Anti-tank Weapon (SRAW/Predator) with the Advanced Anti-tank Weapon System - Medium (AAWS-M/Javelin).

Extrapolating generalizations from case analyses, this thesis identifies the policies, procedures, and methodologies which are most effectual in integrating human considerations into systems acquisition. Finally, the thesis recommends modifications to the Marine Corps' HSI program to improve the acquisition process and thereby, better satisfy the operational requirements of the Fleet Marine Force.

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I. INTRODUCTION

A. PURPOSE

The purpose of this thesis is to analyze how the United States Army and Marine Corps comply with Department of Defense Directive 5000.2, "Defense Acquisition Management Policies and Procedures," which mandates the effective integration of human considerations into the acquisition process. Through comparative analysis, this thesis seeks to identify the policies, procedures, and methodologies which are most effectual in integrating human considerations into systems acquisition. Subsequently, the objective of this thesis is to establish recommendations to enhance the current Marine Corps HSI program.

B. BACKGROUND

Following World War II, military technological superiority became a central tenet of the United States national security policy. Faced with the threat of numerically superior conventional Soviet forces, the U.S. military, from the 1960's through the 1980's, increasingly relied on technology to modernize its forces and generate greater combat power.

This trend continues into the 1990's. With the end of the Cold War, the Services now confront a new array of challenges such as military down-sizing, force reorganization, budgetary reductions, and the increasing costs of manpower and training. The DoD budget is now in its tenth consecutive year of real decline. Since 1990 alone the defense budget authority has suffered a 35 percent decrease in real terms, dropping from $337.3 billion to $252.2 billion (in FY 95 constant year dollars). Procurement has sustained the largest reductions. From 1990 to 1995 procurements shrank by 54 percent or $50.4 billion. Such trends are projected to continue into the new century. Therefore, charged to "do more

with less," the Armed Forces are again compelled to seek technological solutions to their manpower dilemmas.

In the face of fiscal privation, the Services are aggressively pursuing force modernization programs. The Army, in partnership with the Marine Corps, is advancing an expansive technological modernization plan, entitled "Force XXI." Through digitization of battlefield command, control, and communication functions, the program seeks to develop "a new force for a new century," according to General Gordon R. Sullivan, the Army's Chief of Staff. He states that Force XXI will "synthesize the science of computer technology" and "use command and control technology to leverage the power of the information age." (Sullivan, 1994, p.26) Concurrently, the Navy and Marine Corps are actively pursuing technological innovations to expand their littoral warfare capabilities in accordance with the Navy and Marine Corps White Paper "...From the Sea: Preparing the Naval Service for the 21st Century," published on 30 September 1992.

Advanced technology, though, is a dual-edged sword which can either multiply or attenuate a combat force. While offering the potential to enhance performance and mission capability, it can significantly increase system complexity and scope, both operationally and logistically. In addition, failure to address human factors in the acquisition of advanced technology weapons systems and equipment can result in sub-optimal system performance. Historical accounts abound of weapon systems which errantly increased manning and skill requirements, lacked adequate training programs, threatened the health and safety of maintenance personnel, or failed to achieve projected performance levels when employed by the operator.[1] In 1981, a landmark General Accounting Office

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[1] Examples of such incidence include: 1) The Stinger missile system which originally required the gunner to perform 18 sequential steps to fire the weapon, 2) the UH-60

(GAO) report attributed 50 percent of all military equipment failures to human error (GAO, 1981, p. 27). The report confirmed that the effectiveness of U.S. forces could be significantly increased through improved weapon system design. Further, it stressed the immediate need for the integration of manpower, personnel, and training (MPT) considerations into the acquisition process.

Cognizant of the problem, the Department of the Navy in 1977 initiated the Hardware Procurement and Military Manpower (HARDMAN) program to improve its management of MPT requirements generated during the design of new combat systems. HARDMAN was to develop models and databases to analyze new systems designs in terms of their human resource needs. Similarly, in 1984, the U.S. Army inaugurated an expanded program, entitled Manpower and Personnel Integration (MANPRINT), to overcome system design problems and improve human performance and equipment reliability.

In December 1988, the Department of Defense (DoD) formally instituted the manpower, personnel, training, and safety (MPTS) concepts. DoD Directive 5000.53, entitled "Manpower, Personnel, Training, and Safety in the Defense Acquisition Process," established MPTS criteria for all Services. The directive was superseded in February 1991 by DoD Directive 5000.2, "Defense Acquisition Management Policies and Procedures," which mandates that "human considerations shall be effectively integrated into the design effort for defense systems to improve total system performance and reduce costs of ownership." The Directive's objective is to identify

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Blackhawk helicopter which required 24 mechanics per platoon -- six times more than the lowest manpower estimate, 3) the Multiple-Launch Rocket System (MLRS) which suffered severe performance degradation because drivers were not trained in basic map reading, and 4) the Aegis missile cruiser on which misinterpretation of man-machine interface displays resulted in the destruction of a civilian airliner.

for acquisition decision-makers the human factors considerations which will affect the cost and operational effectiveness of a given weapon system.

Although DoD Directive 5000.2 outlined the requirement for human systems integration, the method of execution was left to the discretion of each Service. Since their respective inceptions, the Army and Marine Corps HSI programs have evolved along divergent paths. Each Service refined its HSI policies, procedures, and methodologies according to the unique operational requirements and constraints imposed by their organizational environments. Yet ultimately, the effectiveness of each program is reflected in the operational performance of the combat systems it designs and develops.

The Army is presently the lead service for the design and development of 58 percent of the Marine Corps acquisition category (ACAT) I and II programs.[2] Therefore, seven major Marine Corps combat systems, each costing DoD in excess of $1.2 billion in FY 1980 dollars, are automatically developed under the guidance of the Army's MANPRINT program.[3] Of the remaining Marine Corps ACAT III and IV programs, 16 percent or 14 programs are procured under Army direction employing MANPRINT procedures. Based on this operational inter-dependence and governmental pressures to improve, consolidate, and streamline acquisition procedures, the Marine Corps can

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[2] Programs are assigned ACAT ID and IC designation based on projected RDT&E and procurement costs in excess of $200 million and $1 billion, respectively, in FY 1980 constant dollars. ACAT II, III, and IV programs cannot exceed maximum cost thresholds of $75 million for RDT&E and $300 million for procurement in FY 1980 dollars.

[3] The Army is designated lead service for the following systems: 1) Avenger Missile (Stinger), 2) Advanced Field Artillery Data System (FireFlex), 3) MLRS, 4) Advanced Anti-tank Weapon - Medium (Javelin), 5) Single Channel Ground and Airborne Radio System, 6) Unmanned Aerial Vehicle (Close Range), and 7) Unmanned Ground Vehicle.

benefit significantly by critically evaluating both HSI programs to determine how best to achieve DoD's goal of improved operational performance at reduced cost of ownership.

C. RESEARCH OBJECTIVES

The objectives of this thesis are to:

- Outline the historical development of the Army and Marine Corps HSI programs;
- Conduct a comparative analysis of current HSI policies and procedures utilized by both services;
- Identify the significant benefits and difficulties incurred by both programs;
- Explore opportunities for modification to the Army and Marine Corps HSI programs to improve the efficiency and effectiveness of the acquisition process.

D. RESEARCH QUESTIONS

This thesis poses the question: How can human systems analysis be better integrated into the United States Marine Corps acquisition process in order to improve the operational effectiveness of the Fleet Marine Force?

In addressing the primary question, the following subsidiary questions were considered:

1. What are the objectives of the Department of Defense human systems integration requirements imposed on the military service components by DoD Directive 5000.2?

2. What policies, procedures, and organizational infrastructures currently exist within the Marine Corps to perform human factors integration?

3. How is Manpower and Personnel Integration (MANPRINT) analysis organized and utilized in the United States Army?

4. How has human systems integration/analysis been utilized in the acquisition of major and non-major Army and Marine Corps ground combat weapon systems?

5. What modifications, if any, should be made to Marine Corps human systems analysis policies and/or organizational structures to improve the acquisition process and better satisfy the operational requirements of the Fleet Marine Force?

E. METHODOLOGY

This thesis performs an evaluative analysis comparing how the Army and Marine Corps HSI programs comply with DoD regulations mandating the effective integration of human considerations into the acquisition process. Limited by the lack of centralized Service HSI data bases, this thesis extrapolates generalizations regarding entire HSI programs based on the detailed analysis of representative sample cases. Accordingly, this thesis critically evaluates Army and Marine Corps HSI procedures as applied to the acquisition of one major (ACAT I) and one non-major (ACAT II-IV) weapon system from each Service.

The thesis first establishes a baseline of HSI requirements for all military acquisition programs as set forth in DoD Instruction 5000.2. This baseline establishes the measures of effectiveness against which the Services' HSI programs are evaluated. Secondly, the thesis traces the historical development of the Army and Marine Corps HSI programs to determine the internal and external factors that influenced their current structures. The institutional commitment and organizational infra-structure which support each program are also examined. Finally, through document review and structured interviews of program management personnel, a HSI Attributes Matrix (HSIAM), compares the strengths and deficiencies of each program as judged against the HSI baseline established by DoD. The matrix, presented in Appendix A, evaluates and scores the extent to which acquisition programs comply with DoD requirements relevant to human systems integration.

Based on the results of the comparative analysis, the

thesis proposes modifications to the Marine Corps' HSI program in order to improve the efficiency and effectiveness of the acquisition process. Through better inclusion of the Marine in the acquisition process, this thesis seeks to increase the operational effectiveness of the Fleet Marine Force by improving the total system performance of Marine Corps weapon systems.

The information presented in this thesis was obtained from (1) a literature review of current texts, periodicals, laws, directives, and regulations regarding human factors integration in the military procurement process, and (2) interviews with U.S. Army, Marine Corps, and DoD personnel involved in the systems acquisition process. Literature references were obtained from the materials held at the Naval Postgraduate School, the Defense Logistics Studies Information Exchange (DLSIE), the Defense Technical Information Center (DTIC), the U.S. Army MANPRINT Directorate, the U.S. Marine Corps Systems Command (MARCORSYSCOM), and the Department of Defense. Interviews were conducted both in person and via telephone and are referenced in Appendix B.

F. SCOPE AND LIMITATIONS

The primary focus of this thesis is to increase the operational effectiveness of the Marine Corps operational forces through improved integration of human factors analysis into the systems acquisition process. This objective is achieved by performing a comparative analysis of the policies and procedures of the Marine Corps human systems analysis program and the Army MANPRINT program. Due to its limited nature, the thesis confines its investigation to the acquisition of major and non-major ground combat weapon systems. The acquisition of aviation and automated information systems is excluded from examination. Specifically, the thesis contrasts the HSI procedures employed

in the procurement of the Advanced Amphibious Assault Vehicle (AAAV) with the Armored Gun System (AGS), and the Short-Range Anti-tank Weapon (SRAW/Predator) with the Advanced Anti-tank Weapon System - Medium (AAWS-M/Javelin). These weapon systems were chosen for comparison based on their commonality in form, fit, function, and procurement schedules. In addition, the AAAV and AGS are both under development through a common contractor, United Defense Limited Partnership. This provides a unique opportunity to obtain objective third-party assessments from civilian HSI practitioners intimately involved with both Army and Marine Corps procurement programs.

Research is further restricted to only the Army and Marine Corps HSI programs. Navy and Air Force programs are referenced only for background information or in instances where they directly influenced Army or Marine Corps policies or procedures.

This thesis assumes that the reader understands the basic principles and current policies governing systems acquisition and program management, as well as the DoD, Army, and Marine Corps organizations involved therein. Further, it assumes that the reader has only a limited knowledge of human systems integration and will therefore explain HSI concepts and procedures in detail.

G. ORGANIZATION

The remainder of the thesis is organized as follows:

Chapter II. Evolution of Human Systems Integration in DOD: This chapter provides a historical overview of significant events in the development of the DoD HSI program as delineated in DoD Directive 5000.2. It outlines and examines the HSI requirements imposed on the military services by DoD Directive 5000.2.

Chapter III. The Marine Corps Human Factors Analysis Program: This chapter traces the development of the current

human factors analysis program within the Marine Corps. The chapter identifies the internal and external forces which influenced the evolution of the human factors support structure at Marine Corps Systems Command, Quantico, VA. The chapter also examines the organizational structure and relationships which affect the procurement process.

Chapter IV. The Army MANPRINT Program: This chapter identifies and describes the functions and capabilities of the U.S. Army's MANPRINT methodology. It outlines the development and current status of the Army's MANPRINT support structure. The chapter analyzes the Army's policies and procedures for initiating, executing and employing MANPRINT analysis.

Chapter V. Marine Corps Human Systems Integration Case Analysis: This chapter analyzes the human factors integration/analysis functions performed by the Marine Corps during the procurement of a major and non-major ground combat weapons system. Specifically, the chapter examines the acquisition of the Advanced Amphibious Assault Vehicle (AAAV) and the Short Range Anti-Tank Weapon (SRAW/Predator). It highlights the significant benefits and difficulties incurred by the current operational procedures and organizational relationships.

Chapter VI. Army Human Systems Integration Case Analysis: This chapter investigates the human factors integration functions performed by the Army during the procurement of a major and non-major ground combat weapons system. Specifically, the chapter examines the acquisition of the Armored Gun System (AGS) and the Advanced Anti-Tank Weapon System - Medium (AAWS-M/Javelin). It critically analyzes the benefits and deficiencies of the HSI procedures utilized by the Army to glean recommendations for the improvement of the Marine Corps acquisition process.

Chapter VII. Comparative Analysis: This chapter contrasts policies, procedures, and practices of the Army's

MANPRINT program with the Marine Corps' HSI program. Utilizing the qualitative HSIAM scores, the chapter compares the capability of each Services' HSI program to effectively apply, support, and execute HSI.

Chapter VIII. Conclusions and Recommendations: This chapter summarizes the conclusions derived from the comparative analysis. The chapter proposes recommendations to improve the integration of human considerations within the Marine Corps acquisition process.

H. TERMINOLOGY

The field of human systems integration has steadily evolved and expanded over the last ten years. So too has its language. Since HSI is an inter-disciplinary process, it incorporates terminology from a wide variety of management and technical disciplines. To alleviate confusion, terms that are not commonly known are explained in the body of the text. Whenever possible terms are defined according to DoD standard terminology.

The terms human factors integration and human systems integration are used synonymously in the course of this text. Integration of "human factors" in weapons system design and development is defined as the simultaneous and continuous consideration of six inter-related dimensions which effect human and system performance. The six dimensions are: 1) human factors engineering; 2) manpower; 3) personnel; 4) training; 5) safety, and 6) health hazards. Reference Appendix C for definitions and topical areas covered by each dimension. For this study, a distinction is made between human systems integration and human factors analysis. HSI implies a cross-functional, synergetic examination of human factors considerations, while human factors analysis denotes segregated evaluations.

Finally, numerous military abbreviations and acronyms are

used throughout the thesis. Those that are not commonly known are explained upon first usage. Refer to Appendix D for a list of acronyms and their meanings.

II. EVOLUTION OF HUMAN SYSTEMS INTEGRATION IN DOD

A. INTRODUCTION

The history of systems acquisition within the military services is characterized exclusively by three principle parameters -- cost, schedule, and performance. Program Managers are formally educated and culturally influenced to believe that these factors are the primary focus of their efforts and the criteria for their professional success. For PMs, cost considerations predominate the acquisition equation. By defining the limits of schedule and performance, cost delineates the playing field in which the PMs must compete.

Budgetary constraints coupled with the transient nature of the acquisition work-force and the lack of incentives to the contrary have conspired to further narrow the PMs' focus to initial development and procurement costs. Managers are encouraged, if not specifically directed, to minimize program costs while maximizing performance and maintaining the procurement schedules during their limited tenure in program management. For military officers that period is normally limited to three to four years of a 12 to 15 year procurement cycle for a system that may be employed for decades. The consequence is an organizational culture in which PMs are incentivized to sacrifice long-term life-cycle considerations to achieve immediate short-term returns in cost, schedule, or performance. Therefore, only limited consideration has been traditionally given to the life-cycle costs incurred by manpower, personnel, training, human factors engineering, system safety, and health hazards.

This organizational attitude continues to permeate the acquisition work-force and stands in stark contrast to studies proving that life-cycle costs normally exceed the initial development and procurement costs. Figure 2-1 demonstrates the distribution of life-cycle costs over the standard

acquisition and post-production phases. Typically, 60 percent of systems' costs are incurred during the operations and support phase of the systems life-cycle. The Office of Management and Budget (OMB) demonstrated the breadth of these costs by defining life-cycle costs as "the sum of the direct, indirect, recurring costs, and other related costs incurred or estimated to be incurred, in the design, development, operation, maintenance and support of a major system over its anticipated useful life." (Executive Office, 1976, p.3) In essence, it includes all costs associated with a system from cradle to grave.

As early as 1964, E. G. Fouch, former Deputy Assistant Secretary of Defense, Installations and Logistics, identified this institutional deficiency. He stated:

> Heretofore we have given major attention to the cost of acquiring weapons systems...in terms of development and investment. We have now come to realize that the maintenance and operating costs over the life span, for the most part, far exceed development and investment costs. We are therefore thinking in terms of total cost of effective use and ownership. (Giordano, 1966, p.197)

Experience has shown that a major portion of the projected life-cycle cost for a given system stems from the consequences of decisions made during the early phases of the program planning and system conceptual design. Studies indicate that while a typical program will expend only 10 percent of its developmental budget in the Concept Exploration and Definition phase, the decisions made therein will account for 70 percent of a system's life-cycle costs. (GAO, 1981, p.15) Figure 2-2 illustrates the timing and effect of design and development decisions made during the acquisition process.

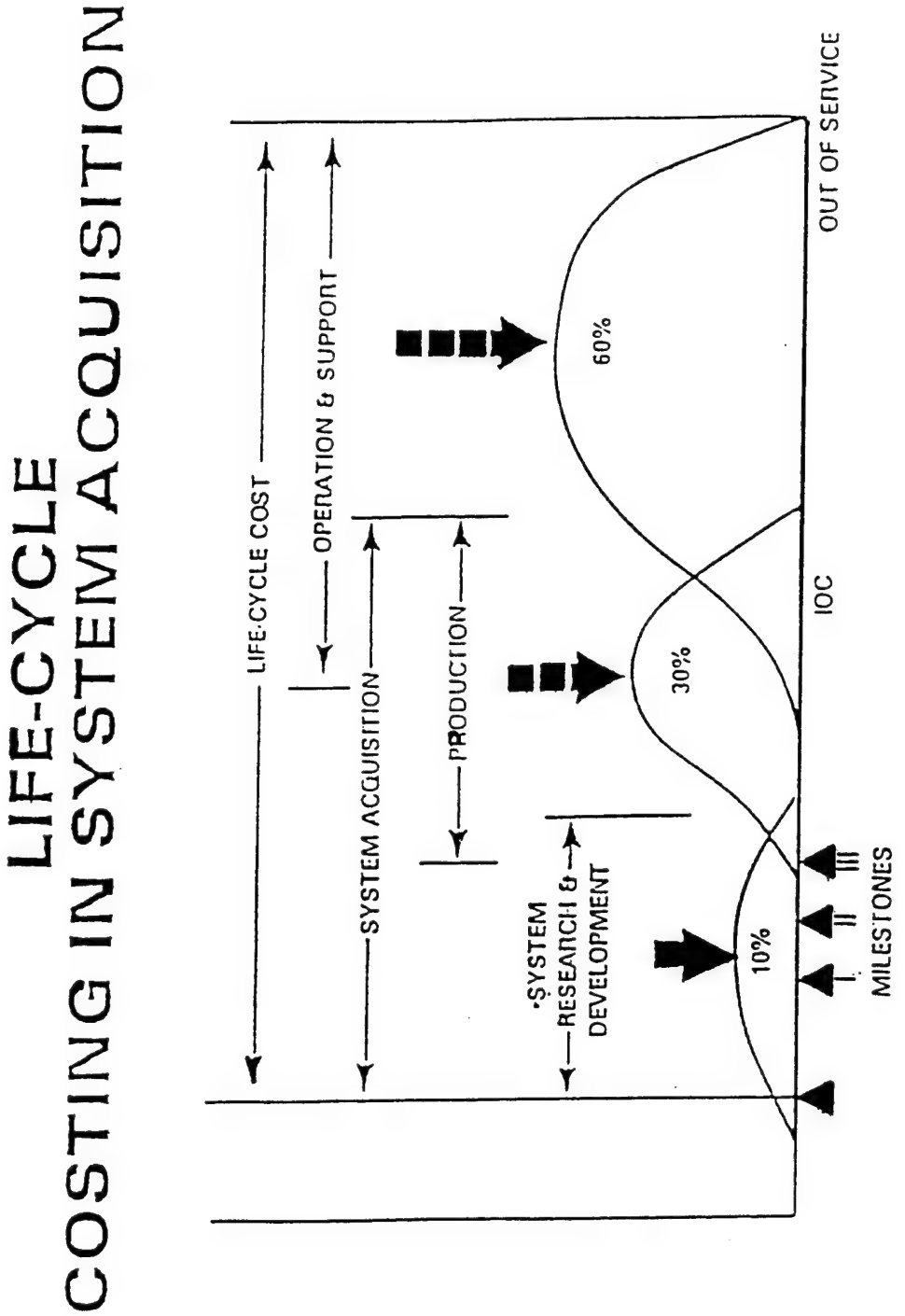

Figure 2-1 Life-cycle costing in systems acquisition. (U.S. Navy, 1988, p. 2-1)

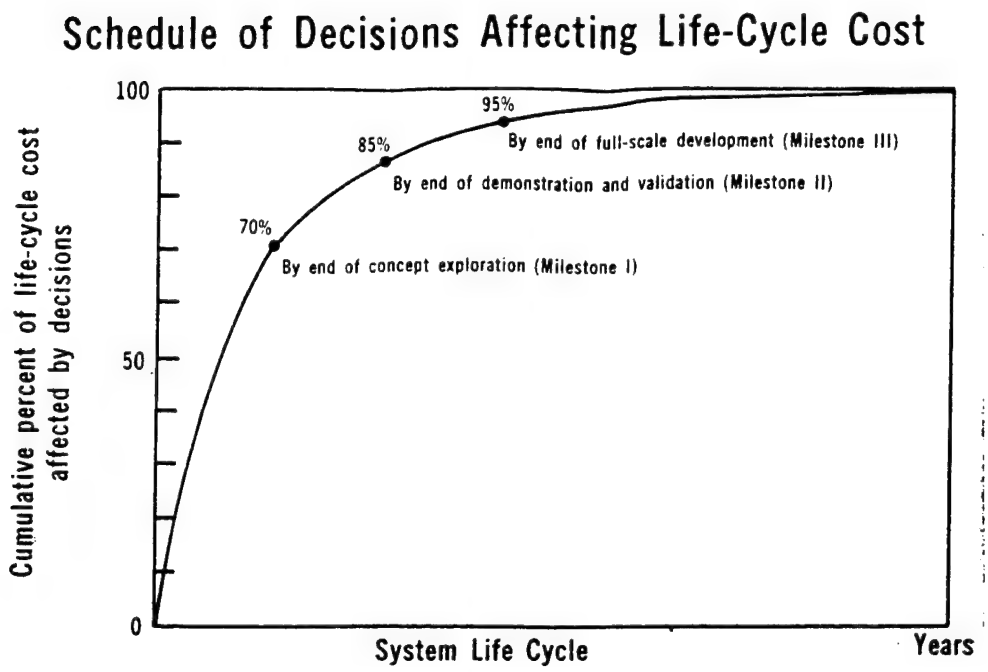

Figure 2-2 Schedules of decisions affecting life-cycle cost. (NSAI, 197, p. 62)

So, while the greatest proportion of costs may result from activities occurring down-stream in the system life-cycle, the greatest opportunity for influencing these costs is realized during the initial phases of the acquisition process.

Because both the Army and Marine Corps are manpower intensive services, the preponderance of these system life-cycle costs are attributable to "people-costs." General Carl E. Mundy, Jr., Commandant of the Marine Corps, in his testimony before the House of Representatives Armed Services Committee on 31 March 1993, emphasized this point by stating that "the Marine Corps is people; we operate people" Both services annually expend over 75 percent of their budgets on manpower costs. General Mundy illustrated this expenditure as follows:

> Some 77 cents out of every dollar you [Congress] provide directly to the Corps is used to buy and support people; 6 cents purchases our ground weapons and equipment; the remaining 17 cents goes toward training, operating, and maintaining readiness and our bases. (Mundy, 1993, p. 29)

Therefore, for the Marine Corps, "people-costs" equate to approximately $6.7 billion of an $8.97 billion yearly budget. Of the Army's 1994 budget of $61 billion, approximately $45.75 billion will be consumed by manpower expenses. Tables 2-1, 2-2, and 2-3 present the DoD, Army, and Marine Corps annual budgets for fiscal years 1994 and 1995.

DEPARTMENT OF DEFENSE
BUDGET AUTHORITY BY TITLE
(Current Dollars, in Billions)

	FY 94	FY 95
Military Personnel	$70.8	$70.5
Operations and Maintenance	88.0	92.9
Procurement	44.5	43.3
Research, Development, Test and Evaluation	34.8	36.2
Military Construction	6.0	5.0
Family Housing	3.5	3.3
Other	1.5	0.9
TOTAL	$249.0	$252.2

Table 2-1 Department of Defense budget. (West, 1994, p. 22)

DEPARTMENT OF THE ARMY
TOTAL OBLIGATION AUTHORITY BY TITLE
(Current Dollars, in Billions)

	FY 94	FY 95
Military Personnel	$26.8	$26.1
Operations and Maintenance	19.7	21.5
Procurement	6.9	6.1
Research, Development, Test and Evaluation	5.4	5.3
Military Construction	0.9	0.8
Family Housing	1.3	1.3
TOTAL	$61.0	$61.1

Table 2-2 Department of the Army budget. (West, 1994, p. 24)

DEPARTMENT OF THE NAVY
UNITED STATES MARINE CORPS
TOTAL OBLIGATION AUTHORITY BY TITLE
(Current Dollars, in Billions)

	FY 94	FY 95
Military Personnel	$6.12	$6.13
Operations and Maintenance	1.94	2.00
Procurement	0.44	0.56
Research, Development, Test and Evaluation	0.21	0.16
Military Construction,Navy	0.13	0.06
Family Housing	0.13	0.16
TOTAL	$8.97	$9.07

Table 2-3 Marine Corps budget. (HQMC, 1994, p. 5-5)

The Department of Defense recognized the implications of the combination of these factors in the development of its HSI

policies. In order to effectively minimize life-cycle costs, specifically manpower costs incurred during the operations and support phase, Program Managers are required to perform up-front analyses of human factors considerations during the initial phases of the acquisition cycle, thereby supporting informed decision-making. Yet, despite this logic, the DoD HSI policies face persistent opposition from an organizational culture in the acquisition community which champions short-term cost, schedule, and performance objectives to the exclusion of human factor considerations and the detriment of long-term life-cycle cost savings.

In an effort to examine the current HSI requirements imposed upon the military services, it is first advisable to trace the evolution of DoD's HSI policy by highlighting the significant historical events and figures which influenced its development.

B. BACKGROUND

1. Problem Identification

In response to the numerically superior Soviet forces confronting the U.S. during the Cold War, the Armed Forces increasingly relied on technology as a force multiplier. In the 1970's and 1980's, the acquisition of technologically advanced weapons systems allowed the Services to compensate for the introduction of the all-volunteer force, widening personnel shortages, and escalating manpower costs. Yet, the failure of many technological advances to increase combat effectiveness to levels projected during systems design increased both Congressional and DoD dissatisfaction with existing acquisition procedures.

As early as the mid-1960's, major human factors programs in the Air Force, Navy, and Department of Transportation had attempted to address the situation. Without exception, however, these efforts to incorporate human factors as a

primary consideration into government policy for technological procurement were marginal at best. (Booher, 1990, p. 5)

No specific DoD-wide guidance on manpower planning for new systems even existed until August 17, 1978 when the Office of the Secretary of Defense (OSD) published a memorandum titled "Manpower Analysis Requirements for Systems Acquisition." Until then, military specifications, standards and handbooks on human factors and human engineering had dealt exclusively with human physical characteristics and design interface. A GAO report later described the manuals' shortcomings as follows:

> Although they furnish a basis for design of the immediate interface between man and machine, they do not provide the broader manpower data (for example, skill levels, proficiency, availability, rotation rates, cost, and so forth) necessary to evaluate alternate designs to determine the optimum design for minimum cost of ownership and maximum effectiveness. (GAO, 1981, p.31)

In his statement before the Senate Armed Services Committee on 14 March 1979, Dr. William J. Perry, then-Under Secretary of Defense for Research and Engineering, acknowledged the dangerous communications gap that had developed between systems developers and the user. This gap, he observed, led to systems that were largely technology driven and poorly united to the operational need because the user did not know how to state his need in terms of available technology. Dr. Perry further stated that DoD research and development programs had applied technology to enhance performance without adequately considering its impact on the user in terms of support costs and the number and skill levels of military personnel. According to Dr. Perry, the results were evidenced by a number of operating systems with low readiness and requirements for expensive retrofits or modifications.

2. GAO Report to Congress

The U.S. General Accounting Office in January 1981 established a milestone in the evolution of DoD's HSI policies when it produced a scathing report criticizing the Services' procurement procedures. The GAO report, titled "Effectiveness of U.S. Forces Can Be Increased Through Improved Weapons System Design," attributed 50 percent of military equipment failures directly to human error. Limitations such as skill levels, proficiency, availability, environmental stress, and fatigue of the personnel who operate and maintain military systems were cited as contributing to human induced systems failure. The report stressed the need to integrate manpower, personnel and training (MPT) considerations into the material acquisition process. To illustrate the point, the report cited a myriad of existing human factors problems existing within the Army, Navy and Air Force to include: a tank hatch that a soldier, clothed for cold-weather, could not fit through; a major shipboard fire control system that could not be adequately manned, and the Dragon anti-armor missile that when fired startles the shooter resulting in misses. As an example, the Dragon system sustained a 60 percent loss in performance efficiency when removed from laboratory conditions and employed by regular soldier's under normal operating conditions.

The GAO report targeted the acquisition work-force's organizational culture as a culprit in propagating the problem. The report observed that:

> The pressures to attain specific performance goals, such as speed, range, and firepower, within the tight time and cost constraints have often led management to trade-off or otherwise not give adequate attention to the long term ownership considerations. (GAO, 1981, p. i)

Management, it concluded, had little incentive to either

invest development funds or to trade-off technical performance to improve the supportability of a system because it is very difficult to quantify the benefits of such actions. One serious problem affecting ownership considerations in the acquisition process noted by the report was the lack of continuity in program management. Military officers were assigned to program management billets about every three to four years. Hence, the report concluded that the program manager is most concerned about what happens on his "watch" and thus less inclined to place emphasis on factors such as supportability, human reliability, and quality assurance where the benefits are realized when the system is deployed (GAO, 1981 p. 57.)

The GAO identified the most prominent detractors from the effectiveness of deployed systems: 1) human factors; 2) logistic support, and 3) quality assurance. The report identified the following human factors deficiencies:

- Human factors specifications, standards, and handbooks used in designing and developing systems and equipment do not adequately address human limitations.
- There are no common methodologies and data sources for use by system designers in forecasting skill levels of future military personnel.
- DoD testing policies and procedures do not tend to identify and resolve potential human-induced failures during the developmental stages of the acquisition process.

The GAO report did acknowledge that the Department of Defense recognized the need for improved personnel planning and human factors analysis. In particular it referenced two on-going initiatives. The first was the Navy's Military Manpower Versus Hardware Procurement (HARDMAN) Program, established in 1977, to develop methodologies for determining manpower requirements associated with systems being developed or procured. The second was the Army Material and Readiness

Command's 1978 instruction to Program Managers and Development Commands to prepare human factors engineering analysis for presentation at the preliminary review of each Army Systems Acquisition Review Council (ASARC) milestone review. Both of these efforts will be addressed in later chapters of this thesis.

Despite DoD's initiatives, the General Accounting Office recommended that Congress direct greater attention during its deliberations on the DoD budget to such matters as human factors, logistics support, and quality assurance considerations in the design and development of weapon systems. Congress responded in Title 10, U. S. Code, Section 2434, "Independent Cost Estimates; Operational Manpower Requirements," by imposing the requirement for a Manpower Estimate Report (MER) of each acquisition program. The report mandates that the military components analyze the impact on manpower and service end-strength in the procurement of new systems.

The Department of Defense concurred with the GAO's findings, conclusions, and recommendations. In commenting, DoD emphasized the need for continuing interaction between system designers and manpower planners and the development of common manpower methodologies. In this way, DoD formally acknowledged a requirement for human systems analysis in the weapon system acquisition process and established a foundation for further HSI policies.

In December 1988, the Secretary of Defense took the next formal step by embracing the manpower, personnel, training and safety (MPTS) concepts. DoD Directive 5000.53, "Manpower, Personnel, Training and Safety in the Defense System Acquisition Process," was approved establishing MPTS criteria that must be addressed by all DoD components in cooperation with industry. The directive stated DoD objective as follows:

> The Department of Defense shall maximize the operational effectiveness of all systems, whether being procured initially or being refurbished, by ensuring those systems can be effectively operated, maintained and supported by well qualified and trained people. To do so, human capabilities and limitations must be fully considered early in the system's design process. Such MPTS concepts, requirements and goals shall be developed in a consistent manner, communicated to industry, and evaluated in contract proposals, and weighed positively and substantially as criteria for source selection.

While DoD Directive 5000.53 was a meaningful step in the evolution of human systems integration within the Department of Defense, it failed to achieve that goal. The new policy did not stipulate the integration of MPTS considerations, merely that each discipline be evaluated in accordance with appropriate directives. Many acquisition practitioners continue to equate the "stove-piped" evaluation of MPTS criteria with HSI. However, in 1991, the DoD 5000 Series ushered in an expanded role and definition of human systems integration, establishing the second milestone on the evolutionary path of HSI policies.

C. DOD "5000 SERIES" ACQUISITION REGULATIONS

1. Background

The 1981 GAO report heralded the growing dissatisfaction with the efficiency and effectiveness of the DoD acquisition process. Increasingly, the acquisition process came under more intense and critical scrutiny from both the executive and legislative branches of government. Headlines proclaiming the exorbitant and sometimes ridiculous costs of systems procurement kept the Department of Defense directly focused in the spotlight of public and media attention.

Four landmark events traced the path of Federal acquisition reform: 1) The Carlucci Initiatives; 2) The Packard Commission; 3) The Goldwater-Nichols DoD

Reorganization Act, and 4) The National Security Review 11 - Defense Management Report.

Under direction of the in-coming Reagan Administration, the Carlucci Initiatives, published on 27 July 1981, set-forth 32 initiatives to improve the acquisition process. The major finding of the review was that readiness could be enhanced, costs reduced, and procurement schedules shortened by decentralized control of the acquisition process.

Similarly, on 30 June 1986, the President's Blue Ribbon Commission on Defense Management published "A Quest for Excellence, Final Report to the President." The Commission, headed by businessman and former Deputy Defense Secretary David Packard, took one year to study the existing defense management and organization. The Commission revealed and reported on the negative effects of over-regulation, inter-service competition, lack of funding stability, and product over-specification. To improve the acquisition process, the Commission's recommendations included 1) shortening lines of communication, 2) identifying who is in charge (and responsible), 3) enlisting smaller, high-quality staffs, and 4) emphasizing innovation, productivity, and smart business practices.

The Goldwater-Nichols DoD Reorganization Act, enacted 11 September 1986, echoed the same opinions. Instead of assigning responsibility to organizational bureaucracies, the Act identified and assigned responsibility to specific individuals. The Act outlined acquisition responsibilities to such positions as the Chairman of the Joint Chiefs of Staff, the Defense Acquisition Executives, and the Service Secretaries. Furthermore, the Act directed a major reduction in headquarters' staffs and congressionally mandated reports.

The National Security Review 11 - Defense Management Report, issued on 12 June 1989, provided a process for selectively implementing the Packard Commission

recommendations and the Goldwater-Nichols requirements. The report provided a final catalyst for a two-year project to revise DoD acquisition regulations which culminated in the publication of the DoD "5000 Series."

2. Policy Objectives

On 23 February 1991, the Department of Defense issued its most comprehensive acquisition reform policy to-date -- the "5000 Series" of acquisition regulations. The policy consists of three publications: 1) DoD Directive 5000.1 -- Defense Acquisition; 2) DoD Instruction 5000.2 -- Defense Acquisition Management Policies and Procedures, and 3) DoD Manual 5000.2M -- Defense Acquisition Management Documentation and Reports. Combined, these documents cancel more than 60 previous DoD directives, instructions, manuals, and memorandum. The three policy documents aspire to the following objectives:

1. Impose a uniformed and disciplined management approach that procures systems which satisfy user needs.

2. Implement the findings from the Defense Management Report;

3. Consolidate and streamline procurement, in order to reduce procurement schedules;

4. Integrate three major programmatic systems: the Planning, Programming, and Budgeting System; the Requirements Generation System, and Acquisition Management;

5. Optimize total system performance with reduced life-cycle ownership costs.

The fifth objective is the cornerstone of the DoD's new HSI policies. First, the policy expands the definition of a total system to include not merely prime mission equipment, but also 1) the personnel who operate and maintain the system, 2) the logistics support structure for the system, and 3) other operational support elements affecting the system. Secondly, the policy cites ownership costs as a major consideration,

thereby shifting program focus from an initial cost basis (acquisition costs) to a life-cycle cost basis. Since "people costs" are the most expensive component of life-cycle costs, the "5000 Series" then strives to ensure that human factors are considered during all phases of the acquisition process.

3. DoD Policy

The new DoD policy on human systems integration is established in DoD Instruction 5000.2, Part 7, Section B, Human System Integration, which replaced DoD Directive 5000.53, "Manpower, Personnel, Training, and Safety (MPTS) in the Defense System Acquisition Process." The policy states:

> Human considerations ... shall be effectively integrated into the design effort for defense systems to improve total system performance and reduce costs of ownership by focusing attention on the capabilities and limitations of the soldier, sailor, airman, or Marine.

The human factors objectives, the policy continues, must be traceable to readiness, force structure, affordability, and wartime readiness.

The policy delineates six human considerations to be integrated by program management: 1) human factors engineering; 2) manpower; 3) personnel; 4) training; 5) system safety and 6) health hazards. Appendix B defines the HSI terminology utilized in the 5000 Series. Human factors, and system safety, health hazards and environmental impact are also addressed separately in Part 6, Engineering and Manufacturing, sections H and I, respectively. To ensure compliance with the policy guidance, DoD Instruction 5000.2 standardizes HSI documentation contents and formats for ACAT I programs process. Part 2, paragraph C.3 of the directive stipulates that acquisition procedures and documentation may be tailored for ACAT II through IV programs subject to the approval of the milestone decision authority.

The human factors objectives for systems are initially established at Milestone I, Concept Demonstration Approval, and subsequently refined and updated at successive milestone decision points. From the outset, human system constraints are addressed in two basic requirement documents: the Mission Needs Statement (MNS) and the Operational Requirements Document (ORD). The MNS establishes the manpower, personnel, training, and safety constraints which may impact the development of a system to satisfy the user's need. Reaffirming the MNS constraints, the ORD establishes MPTS objectives and thresholds. In addition, the ORD specifies the manpower and training methodologies to be used. The Test and Evaluation Master Plan (TEMP) also addresses human performance issues. The TEMP provides data to validate that manpower, personnel, training, systems safety, and health hazard design requirements have been met.

The heart of DoD's human systems integration policy is the Human System Integration Plan (HSIP) which is contained in the Integrated Program Summary (IPS). The IPS is the primary decision document used for milestone review. The IPS summarizes the program status, identifies risk areas and plans for abating them, and provides a basis for cost, schedule, and performance objectives and thresholds.

4. The Risk Assessment Annex

The Risk Assessment Annex is Annex D of the Integrated Program Summary. The annex is a portion of a program's overall risk management strategy which attempts to identify and manage areas of vulnerability or concern. Annex D describes the threat, technology, design and engineering support, manufacturing, cost and schedule risk assessment for all known or potential risks. The annex identifies the system component(s) or subsystem(s) which have moderate or higher risk. The Annex is required to:

1. Summarize potential cost, schedule, and design risks that result from human systems integration factors;

2. Highlight current human systems cost drivers. Discuss the manpower impact of the most promising alternative system(s) as compared to its predecessor or comparable systems;

3. Discuss major cost, schedule, and performance trade-off decisions to be made by the Milestone Decision Authority for current or subsequent milestones.

5. HSIP Requirements

Within the Risk Assessment Annex is the Human System Integration Plan. The HSIP requires the performance of seven functions:

1. Identify critical human systems factors that have a significant impact on readiness, life-cycle cost, schedule, or performance. It should include potential cost, schedule, and design risks and trade-offs which concern human systems integration factors and plans to manage and reduce program risks;

2. Discuss the manpower impact of the new system as compared to its predecessor or comparable system(s) and state the sources of the manpower resources for the new system;

3. Discuss requirements for new occupational specialties, requirements for high quality personnel or "hard-to-fill" military and civilian occupations and how these personnel requirements will be met;

4. Describe how human factors engineering will be applied to the system design effort;

5. Summarize how safety and health hazard lessons learned are being applied to the new system;

6. Address the training requirements and effectiveness of the new training system. It should include requirements for new or additional training resources and identify critical points in the training schedule;

7. Discuss the impact of fielding the new system will have on unit readiness and whether the training base is adequate to meet surge and mobilization requirements.

Appendix C shows the prescribed format for the HSIP.

6. Policy Intent

The driving force behind the HSI policy was DoD's intention for Program Managers to perform trade-off analyses between the six disciplines in an integrated manner to achieve enhanced total system performance while reducing life-cycle costs. Nina Richman-Loo, Program Analyst, HSI Division, Office of the Under Secretary of Defense for Personnel and Readiness, confirms that previous decisions regarding manpower, personnel, and training were separately evaluated or "stove-piped" within the Services. She states:

> ...although these disciplines were affected by acquisition and were impacted by acquisition, they had no play in the acquisition process. So, rather than having all these different 'stove-piped' activities, human systems integration attempted to bring all of these important players together and form an interface with the acquisition community.

DoD's intention to evaluate and integrate the disciplines through trade-off analyses is further illustrated by the HSI model provided in DoD Instruction 5000.2, Part 7, Section B, and depicted in Figure 2-3.

Finally, by locating the HSIP within the IPS rather than within the Integrated Logistics Support Plan (ILSP), DoD also signalled its intention to segregate and balance HSI and logistical concerns. HSI was established as a distinct segment of the risk management, rather than being grouped under logistical oversight.

7. Policy Reform

In accordance with on-going acquisition reform and the Clinton administration's initiative to "reinvent government," Defense Secretary William J. Perry is leading an offense against the use of military standards and specifications in the military procurement process. In the last 15 years, more than 25 blue-ribbon panels and academic studies have

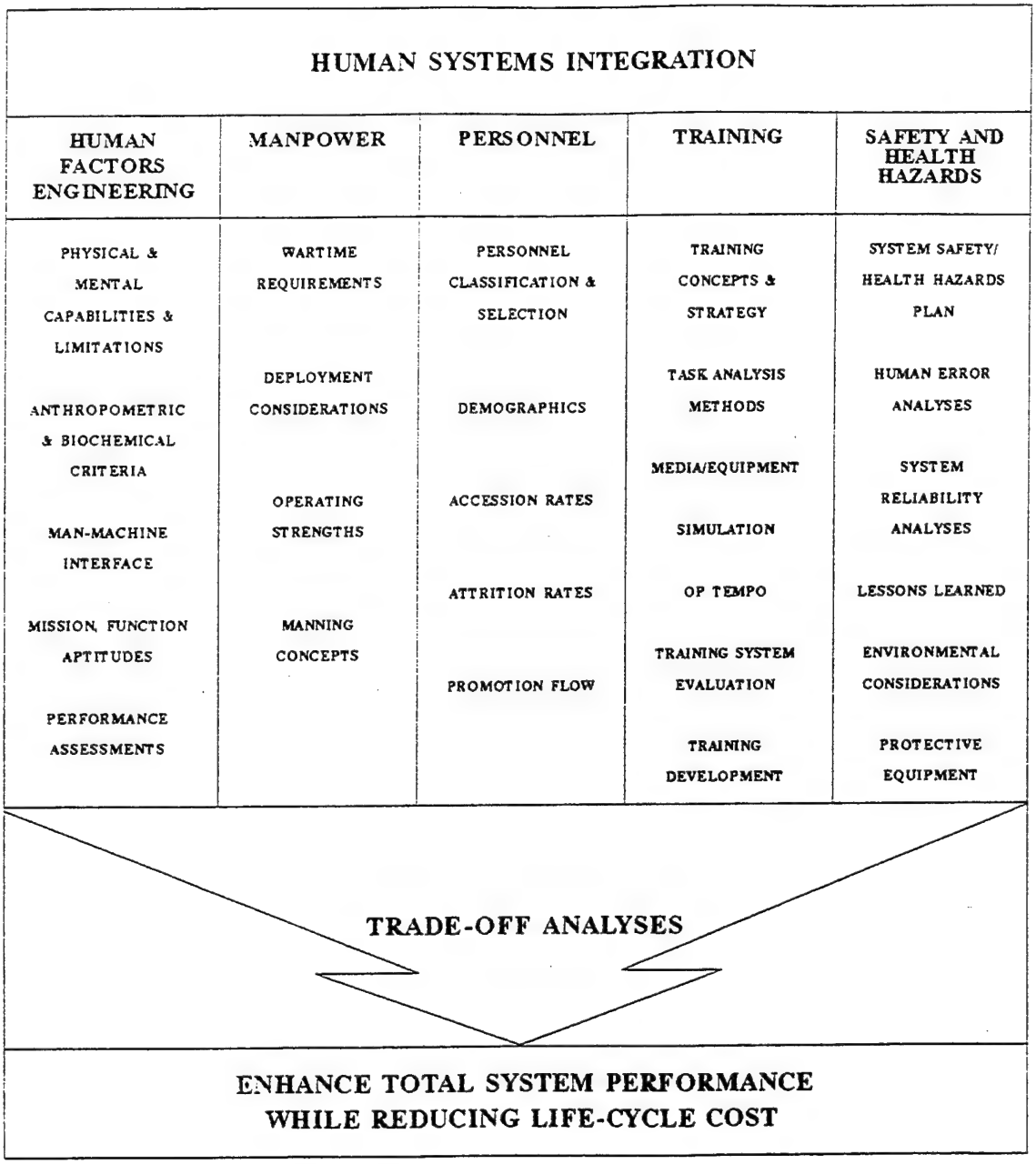

Figure 2-3 Department of Defense human systems integration model. (DODI 5000.2, 1991, p. B-2)

recommended ending the use of MIL-SPECS. Dr. Perry, a former Stanford University national security expert and defense industry executive, was involved in many of them. On 29 June 1994, Perry set forth his policy. He directed the Armed Forces to acquire as many products and components as possible from the commercial marketplace. Commercial purchases are to be the rule, and procurement by MIL-SPEC is to be by exception only.

Secretary Perry's directive states that acquisition officials must specify performance criteria for military equipment, rather than dictating exacting military specifications and standards. The initiative, Perry says, will save billions of dollars a year, and "fundamentally change the way we do business ... turning the present system upside down." (Mintz, 1994, p. A29) Some purchases will still follow MIL-SPEC rules, such as highly classified programs and those requiring highly specialized components.

The new policy will have significant repercussions on the establishment, direction, and supervision of human factors issues throughout the DoD procurement process. Previously, human factors practitioners relied extensively on MIL-STD-1472D, Human Engineering Design Criteria for Military Systems, Equipment, and Facilities, and MIL-STD-1800, Human Factors Engineering Performance Requirements for Systems, to delineate system design guidelines. With the curtailment of military specifications, standards, and Data Item Descriptions (DID), procurement officials will have to rigorously define and track the individual performance standards their system is to achieve. Performance criteria will have to be identified early in the development process for inclusion in contract negotiations. The risk of exclusion or omission of human factors criteria is heightened, according to a Human Factors Engineering Consultant to United Defense, L.P., in organizations which have not institutionalized systematic

approaches to human systems integration.

The Deputy Under Secretary of Defense for Acquisition Reform has also established three Process Action Teams to examine the acquisition process, acquisition documentation, milestones, and oversight. The recommendations of these teams are projected to further consolidate and streamline the current HSI procedures of the individual Services.

D. SUMMARY

Human systems integrations is still in its infancy within the Department of Defense. DoD's HSI policies grew from the failure of the military services to adequately address MPTS issues during the rapid force modernization efforts of the Cold War. Two documents serve as landmarks in measuring the maturation of these policies; first is the GAO's critical 1981 report, entitled "Effectiveness Can Be Increased Through Improved Weapon System Design," and second is the DoD 5000 Series.

The GAO report criticized DoD's production of military systems that could not be adequately operated, maintained, or supported. The report credited the blame to the organizational culture in which pressures to attain specific performance goals within tight time and cost constraints often led management to trade-off or otherwise not give adequate attention to long-term ownership considerations. Following its publication, DoD moved to strengthen and balance human considerations against cost, schedule, and performance criteria in the development of weapon systems.

Responding to Congressional calls for acquisition reform, the 5000 Series formalized DoD's HSI requirements throughout the Armed Forces. DoD mandated that Program Managers establish and execute a Human Systems Integration Plan to adequately address the six human factors disciplines. The policy's intent was to eliminate "stove-piped" staffing of

human considerations, in favor of full integration of the disciplines. The policy sought to establish a forum for the identification, documentation, and informed consideration of human issues.

To what degree DoD has achieved its policy objectives can be best measured by evaluating the effectiveness of the Service HSI programs developed and operating under its guidance. To this end, Chapters III and IV will examine the HSI policies, procedures, and organizations of the Marine Corps and Army, respectively. Chapters V and VI will then analyze the effects of these HSI programs on the procurement of major and non-major ground combat weapons in both Services.

III. THE MARINE CORPS HUMAN SYSTEMS ANALYSIS PROGRAM

A. INTRODUCTION

The Marine Corps' unique acquisition policies, procedures, and organizational structure are the result of numerous internal and external forces. First and foremost, as a component of the Department of the Navy, the Marine Corps is subject to the acquisition policy guidance set forth by both the Office of the Secretary of Defense and the Secretary of the Navy. Secondly, due to funding and organizational constraints, the majority of the Marine Corps' major acquisition programs are conducted in coordination with the U.S. Army and Navy. Thus, the Marine Corps is formally and informally influenced by the operating procedures of its sister Services. Finally, the Marine Corps acquisition process is molded by the decisions of the Service's senior acquisition officials, as well as the normal day-to-day operating procedures and relationships established in the execution of acquisition responsibilities. Consequently, before the Marine Corps' HSI program can be evaluated in application, the forces which influenced its development and current status must first be identified and analyzed.

B. HISTORICAL DEVELOPMENTS

1. The U.S. Navy HARDMAN Program

As early as 1962 the Department of the Navy recognized the role of human factors within the acquisition process with the publication of MIL-H-22174. By 1965, the Navy initiated a formal human factors program with the publication of MIL-H-81444, which mandated human factors engineering plans and specified programs. However, in the late-1970's the focus of the Navy's HSI efforts shifted to the reform of its manpower, training and personnel (MPT) bureaucracy, which was assessed by the Salzer Study in 1976 as being the "weak sister" of the Service's management structure. The subsequent evolution of

the Navy's MPT program provides a historical backdrop to the Marine Corps' HSI program, as well as a unique case study of ineffectual HSI program implementation.

In response to Congressional pressure and a growing concern that technological innovations were outpacing MPT capabilities, the Navy contracted for a Military Manpower Versus Hardware Procurement (HARDMAN) Study in 1977. The HARDMAN study documented that "there has been a continuing concern on the part of Navy planners with respect to their capability to adequately anticipate as well as meet the manpower and training requirements associated with ... 700 different Navy projects involving approximately $90 billion in procurement" (Weedle, 1983, p.124). Therefore, the goal of the research was to analyze the compatibility of the manpower and training requirements determination functions with the Weapons Systems Acquisition Process (WASP), the institutionalized setting in which all man/machine or capital/labor tradeoffs must occur. (CNO, 1977, p. 1)

The study concluded that manpower/hardware trade-offs occurred too late in the acquisition process, and that key participants lacked incentives with respect to determining and ensuring visibility for manpower and training requirements. In an effort to rectify these conditions, the study presented the following recommendations:

- Establishment of a HARDMAN Project Office to ensure manpower issues are properly integrated into the WSAP;
- Development of hardware/manpower trade-off capabilities to support early identification of manpower requirements;
- Implementation of analytical tools and review procedures to support HARDMAN functions;
- Institution of a reporting and control system for HARDMAN functions.

The study resulted in the development of the Military

Manpower/Hardware Integration (HARDMAN) Master Plan in 1979, and a draft HARDMAN program in 1983. The program's goal was the formation of models and data bases to analyze new system designs in terms of their human resource needs. In order to save research and development time and money, the necessary analytical tools were derived from an earlier program, entitled Coordinated Human Resource Technology (CHRT), sponsored by the Air Force Human Resource Laboratory. The Navy methodology capitalized on the lessons learned from the CHRT project, added greater dimension to its analytic capability, and tailored its products to the technical and managerial information needs of the acquisition work-force.

Following contractor testing of HARDMAN on nine weapon system development programs from March 1983 to May 1985, the Chief of Naval Operations (CNO) approved implementation of HARDMAN throughout the Navy for all new major and non-major programs originating after 1 October 1985. OPNAVINST 5311.7 of 12 August 1985 directed HARDMAN use on all programs, ACAT I through IV. The HARDMAN program required Program Mangers to:

- Complete a HARDMAN MPT Concept Document describing how personnel would operate a typical weapon unit;
- Complete a HARDMAN MPT Resource Requirements Document detailing the number and skills of personnel needed to use and maintain the weapon during its life-cycle;
- Establish a HARDMAN Advisory Board to validate the MPT estimates and advise the project manager on suggested design concept changes;
- Make trade-offs between hardware designs and personnel number and skills.

Despite its initial promise, the HARDMAN program failed to achieve the successful integration of MPT considerations into the acquisition process. The Auditor General of the Navy reported in 1987 that of 75 programs selected for audit, only

two were fully using HARDMAN. Nineteen of 20 ACAT I and II projects reviewed had received Milestone I approval without completing HARDMAN. The report concluded that the HARDMAN program was ineffective because of its limited use and incomplete development, and consequently the MPT problems it was designed to address remained unsolved. (Auditor General, 1988, p. i)

Program managers were criticized in the report for not employing the HARDMAN program to perform trade-off analyses before the Navy had become deeply committed to a specific weapon system design. In response, the Naval Air Systems Command (NAVAIR) stated that HARDMAN produced an excess and redundant burden on PMs, and that the documentation was perceived as not required. Naval Sea Systems Command (NAVSEA) personnel stated that they were unaware of the requirement, while Naval Space Systems Command (SPAWAR) personnel cited lack of program awareness or confusion about HARDMAN's importance prior to concept development. Despite the requirements of OPNAVINST 5311.7, many PMs expressed the belief that HARDMAN did not apply because their programs were up-grades or modifications of older systems, "off-the-shelf" or non-developmental systems, or ACAT III or IV projects.

The results of the Auditor General's report and subsequent interviews with DoD acquisition personnel emphasize lack of commitment by senior Naval officials as a key factor in the ineffectual implementation of the HARDMAN program. The study criticized the Chief of Naval Operations specifically on two points: first, for not integrating HARDMAN into the key Navy acquisition instructions, and secondly, for not formalizing administrative controls to monitor HARDMAN use. In short, the study chastises the Navy for providing "lip-service" to the HARDMAN program by failing to provide guidance or incentives for its performance. The implications of the study are that the HARDMAN program was not actively supported,

promoted, or enforced by senior Naval officials, and therefore was never institutionalized into the acquisition process.

Research interviews reveal that this situation remains unchanged. Numerous acquisition personnel emphasized that to date no senior Naval official has actively championed the HARDMAN program or similar HSI efforts. One senior HSI practitioner stated that the HARDMAN program lacked "high-level visibility and proponency, which is absolutely essential." HARDMAN, he noted, has become merely a bureaucratic exercise, predisposed to fail.

On-going attempts to revise the HARDMAN program and to obtain organizational commitment currently continue. A report prepared for the CNO in April 1994 by the Naval Aviation Maintenance Office documents the current efforts to streamline the suite of nine HARDMAN methodology manuals into a more accessible Training Planning Process Methodology (TRPPM). Although HARDMAN does not encompass safety and health hazards issues, as DoD Instruction 5000.2 requires, the report nonetheless states that at present the only documented procedures the Navy has which will fulfill the DoD requirements are contained in the HARDMAN Methodology. Optimistically, it states that if HARDMAN methodology procedures are timely and aggressively applied with the proper spirit and intent, they would fulfill the requirements of DoD Instruction 5000.2, produce an MPT-efficient system, and provide a valuable audit trail. Yet realistically, it warns that if the procedures are compromised or not enforced it is questionable whether the DoD requirements will be met and the resulting weapon system's MPT requirements may be less than optimum.

While the HARDMAN program began as a proactive and innovative effort to address critical MPT issues in the procurement of increasingly technical weapon systems, its full potential was never realized. The program lacked the

necessary commitment of senior management to foster its advancement and service-wide institutionalization. Consequently, HARDMAN, while providing an effective methodology for MPT analysis, failed to mature into a human systems integration program.

2. Foundation of the Marine Corps HSI Program

The Marine Corps' HSI efforts evolved from the shadows of the HARDMAN program. In 1987, the Marine Corps received a critical report from the GAO, entitled "Improvements Needed in Processes for Determining Manpower Requirements." With the Marine Corps expending $5.3 billion or approximately 58 percent of its total budget on personnel costs in fiscal year 1987, the report argued that the Marine Corps needed to determine its manpower requirements in as systematic a manner as possible. Instead, the GAO found that the Marine Corps procedures used to determine manpower requirements lacked adequate rigor and that there existed insufficient oversight of the manpower program. The report cited that too often manpower standards were based on the judgment of Marine Corps officials or on formulas of undeterminable origin. One recommendation emanating from the report was that the Commandant of the Marine Corps issue guidance governing the development and application of manpower determination processes and require systematic management oversight. DoD concurred with this proposal.

In its efforts to control expanding MPT issues in the acquisition process, the Marine Corps availed itself to the Navy HARDMAN program, and tailored it to suit the Marine Corps requirements and organizational structure. The HARDMAN methodology became and continues to be the focal point of the Marine Corps HSI program. Because it addresses and integrates two of the major issues confronting senior Marine Corps officials over the last two decades -- manpower management and training effectiveness -- HARDMAN analysis has received the

lion's share of attention from among the HSI disciplines. Due to this emphasis, HARDMAN has become a cultural icon for HSI within the Marine Corps' organizational culture. Even though human factors engineering, and health hazards and system safety analyses are performed separately, numerous acquisition personnel continue to equate HARDMAN methodology with the execution of human systems integration. During numerous interviews, Marine Corps acquisition personnel used the terms HARDMAN, HSI, and MANPRINT interchangeably to describe methods of fulfilling DoD's HSI requirement.

Like the Navy, the Marine Corps has yet to have a senior Marine official champion the cause of human systems integration within the acquisition process. Hence, in keeping with the findings of the Navy Auditor General's report, the Marine Corps acquisition community still lacks clearly defined guidance and incentives for the performance of HSI. Whereas the DoD established its HSI requirements in February 1991, the Marine Corps did not issue its implementation order, Marine Corps Order 5000.22, until August 1994. In the interim, HSI requirements were applied at the discretion of and according to the interpretation of the Program Manager or supporting Logistical Engineering Manager (LEM). Therefore, to clarify the Marine Corps HSI policies and procedures, the next two sections will construct a model of the current HSI program based on an analysis of the agencies and organizational relationships involved therein.

C. ORGANIZATIONAL OVERVIEW

1. General

Responding to the evolutionary DoD acquisition process, the Marine Corps began the formalization of its combat development process (CDP) in November 1987, with the creation of the Marine Corps Combat Development Command (MCCDC) and the Marine Research, Development, and Acquisition Command

(MCRDAC). MCRDAC was subsequently redesignated as the Marine Corps Systems Command (MARCORSYSCOM) in 1992.

Publication of the revised DoD 5000 Series provided guidelines to the Services to more closely link the functions of requirements determination and material acquisition. Subsequently, according to MCO P3900.15, "Marine Corps Combat Development Process," the Marine Corps modeled its process for the development of doctrine, organization, training and education, and facilities and support requirements after the process mandated by the DoD 5000 Series.

The organizational structure for the Marine Corps acquisition process is based on a triad of inter-relationships. The organizational elements are Headquarters Marine Corps (HQMC), MCCDC, and MARCORSYSCOM. Figure 3-1 highlights the key functions and inter-relationships of each of these organizations in the material acquisition process. At the intersection of their responsibilities is the mission to efficiently and effectively man, equip, and fund the operations of the Fleet Marine Force. The following two sections briefly outline the organizational roles of HQMC and MCCDC as they affect the acquisition process, while the third section details the operational responsibilities and procedures of MARCORSYSCOM.

2. Headquarters Marine Corps

The Commandant of the Marine Corps holds ultimate responsibility for the combat development acquisition process. Within the acquisition process, HQMC is primarily responsible for program development and integration, logistics and facilities management, and manpower management. In is in the role of manpower and personnel manager that HQMC influences human systems integration. Specifically, it is the Deputy Chief of Staff for Manpower and Reserve Affairs (DC/S M&RA)

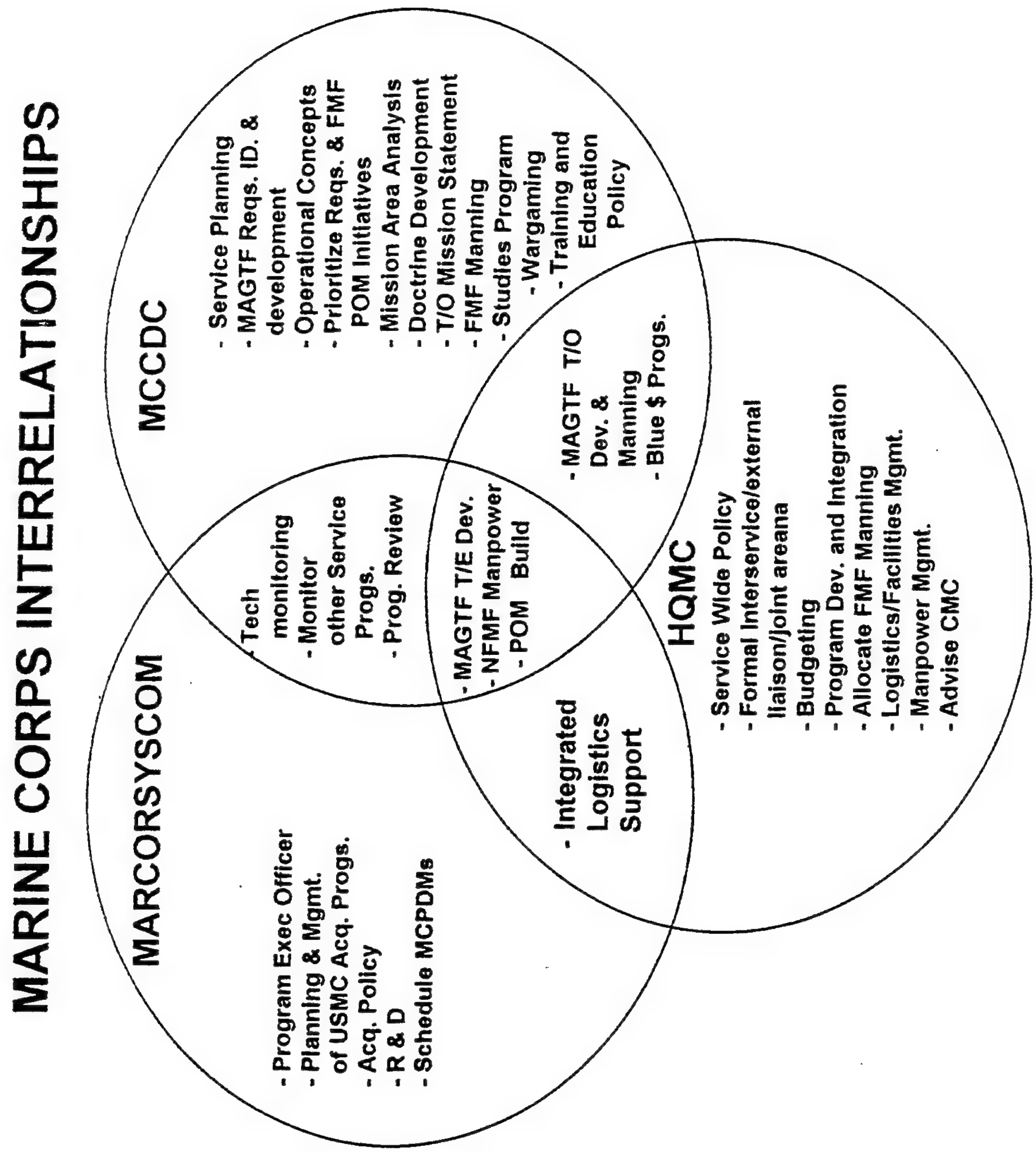

Figure 3-1 Functional inter-relationship of HQMC, MCCDC, and MARCORSYSCOM. (U.S.M.C., 1993, P. 7)

who acts as the Commandant's representative in performing Marine Corps-level structure sponsorship functions. The DC/S M&RA's responsibilities include the following:

1. Manages the Table of Manpower Requirements data base;

2. Assists CG MCCDC and COMMARCORSYSCOM in developing manpower and personnel requirements in support of the systems acquisition process;

3. Provides input as required by CG MCCDC on manpower related issues developed during the CDP;

4. Coordinates with CG MCCDC on Joint Service considerations related to manpower issues in the Marine Corps Master Plan and other internal Marine Corps plans.

Previously, HQMC was also responsible for Marine Corps ground safety analysis. In October 1993, this function was assumed by the Naval Safety Center, Norfolk, VA.

3. Marine Corps Combat Development Command

Located at MCB Quantico, VA, MCCDC was restructured from elements of MCRDAC in late 1987. The CG MCCDC is responsible to the CMC for the implementation, execution, and management of the combat development process. General responsibilities include coordination with HQMC, MARCORSYSCOM, field command and Marine Reserve Forces on matters pertaining to combat development. Relevant to this study are the following development responsibilities:

1. Determine, staff, and validate operational requirements for doctrine, organization, training and education, equipment, and facilities and support;

2. Monitor the execution of the programs designed to achieve war-fighting capabilities;

3. Assist COMMARCORSYSCOM in the focus of long-range research and development of equipment.

Initially, MCCDC's functional responsibilities were consolidated into three organizations: the Training and

Education Center, the Warfighting Center; and the Support Center. The first two organizations were directly involved in the requirements determination/validation and acquisition process. The Warfighting Center acted as the operational proponent of the Fleet Marine Force (FMF). It was tasked with the development of the ORD and Concept of Employment documents for new weapons systems. Alternately, the Training and Education Center conducted the development of related training requirements and plans in reaction to the evolution of tactical and equipment changes identified by the Warfighting Center. This included the creation of training packages, identification of formal schools and associated facility support, management and oversight of the schools and their courses of instruction, and development of individual training standards.

Upon assuming command of MCCDC in 1991, Lieutenant General Charles C. Krulak reorganized the MCCDC. The organizational structure of the command was reconfigured from three to ten sub-units. Figure 3-2 illustrates the current organizational structure. Five organizations now report directly to the CG MCCDC on requirements determination and validation and the acquisition process: Training and Education Division; Doctrine Division; Warfighting Development and Integration Division; Requirements Division, and Concepts and Plans Division. The effects of this reorganization still impact the Marine Corps HSI program as practitioners reconfirm and realign operational relationships and responsibilities. Several program management and support personnel interviewed for this research expressed confusion or doubt concerning which agency actually represented the needs of the operational user or maintainer during systems acquisition.

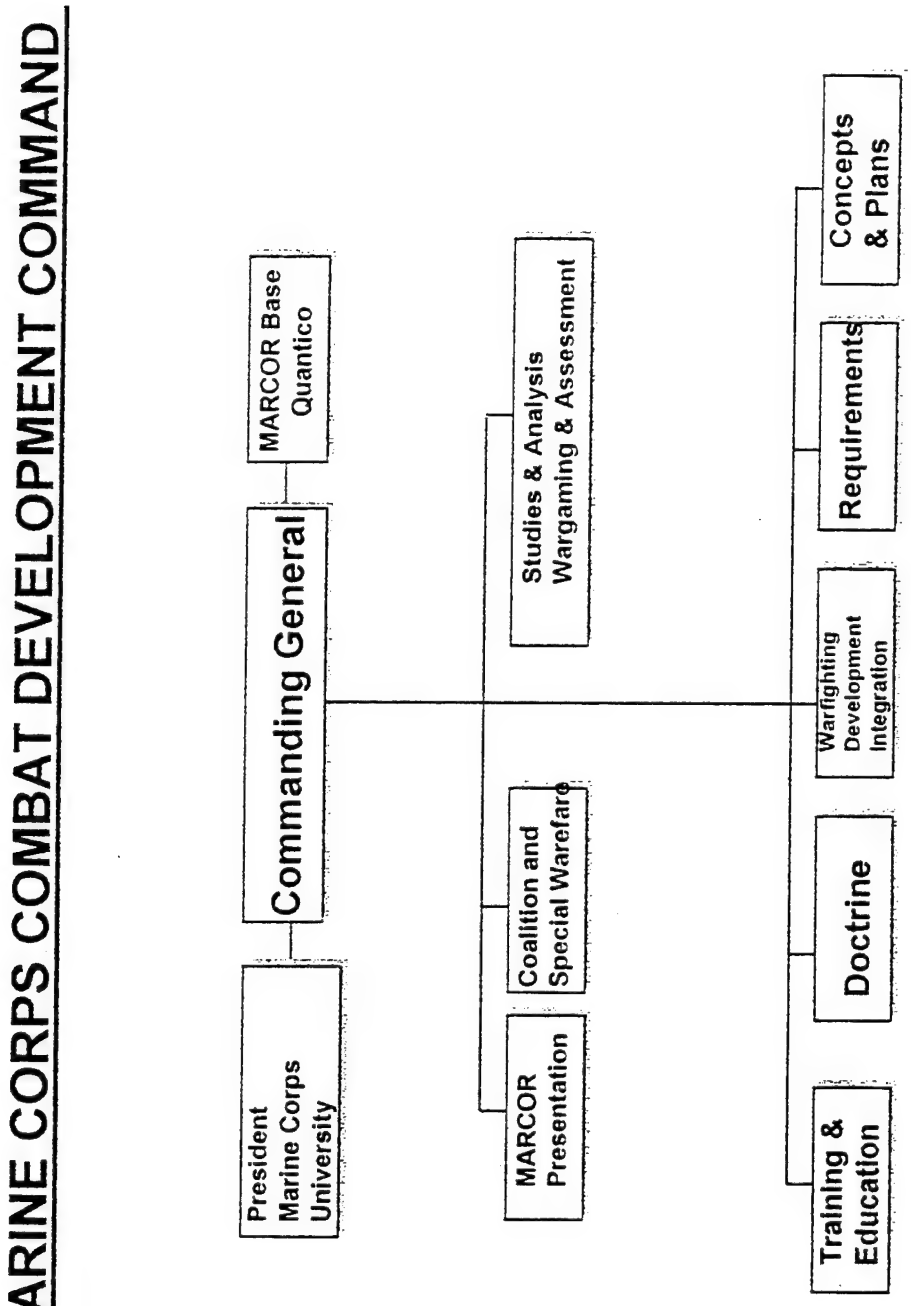

Figure 3-2 Marine Corps Combat Development Command organizational structure. (U.S.M.C., 1993, p. 36)

4. Marine Corps Systems Command

Marine Corps Systems Command bears primary responsibility for oversight and management of the acquisition process. The command is chartered with the responsibility of taking the requirement validated by MCCDC and producing the appropriate weapon system or equipment. MARCORSYSCOM oversees the contractual, analytic, and planning requirements for system development, procurement, and fielding. Further, it coordinates with other services which may have "lead Service" responsibilities for development of multi-Service systems.

The responsibility, authority, and accountability for all Marine Corps acquisition programs resides with the Commander MARCORSYSCOM. She plans and manages Marine Corps acquisition programs and implements DoD acquisition policy within the Marine Corps. The Commanding General reports directly to the CMC. As the Program Executive Officer for the Marine Corps, she also reports to the Assistant Secretary of the Navy, Research, Development and Acquisition (ASN, RD&A) regarding acquisition matters. Specific responsibilities include:

1. Serve as sole organization responsible for the execution of program management during the RD&A process and for life-cycle management of all ground tactical weapon systems and equipment;

2. Coordinate with CG MCCDC to ensure that acquisition programs are developed to fulfill validated requirements;

3. Provide the Life-Cycle Cost Analysis, projecting the total cost to the Government of a system, to include the cost of development, acquisition, operation, support, and where applicable, disposal.

Figure 3-3 depicts the current organizational structure designed to support the Commander in the execution of her duties. The responsibilities of the agencies directly involved in the performance of human systems analysis are summarized below.

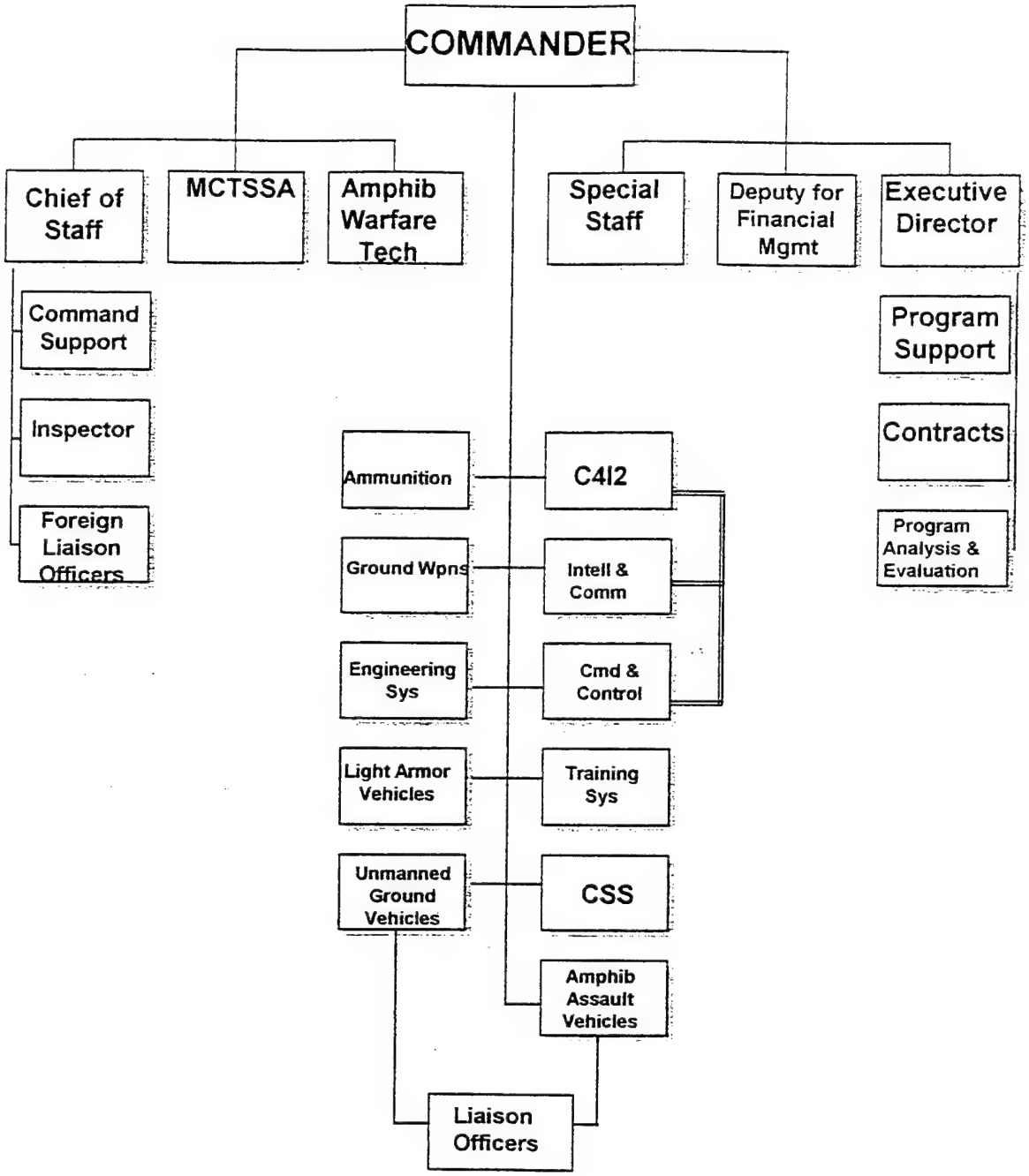

Figure 3-3 Marine Corps Systems Command organizational structure. (MARCORSYSCOM, 1994, p. 1-3)

Under the direction of the Executive Director, the Program Analysis and Evaluation Office (PA&E) provides support to the Commander in her role as Milestone Decision Authority (MDA) by conducting assessments of acquisition programs and processes. Further, the PA&E Office provides support to the Commander in her role of COMMARCORSYSCOM by assisting in the preparation of programs for review by ASN (RDA) and by acting as the focal point for implementing ASN acquisition policy. The office is tasked with the following functions:

1. Manage the Program Review process with the Command. Conduct follow-up review to ensure the accomplishment of taskings by the Commander;

2. Coordinate the conduct of Marine Corps Decision Meetings, to include the preparation of the Integrated Program Assessment;

3. Maintain centralized records documenting the progress of each program in achieving milestone decisions;

4. Assist PMs in developing acquisition strategies and in tailoring these strategies and related program documentation.

The PA&E office maintains oversight authority to ensure that material requirements documents accurately describe achievable and testable hardware solutions to mission deficiencies.

Within MARCORSYSCOM there are 11 program management offices organized by operational area of system employment and further sub-divided into project teams. The mission of the PM is to plan, budget, execute and administer the RD&A, fielding, and life-cycle support of assigned equipment and weapon systems. Forty-one common functions are assigned to the PMs. They are personally tasked to "insure that human factors and man-machine interface are integral parts of system design." Within the program offices an Integrated Logistics Support (ILS) Manager is responsible for the oversight of ILS issues within the separate projects.

The PM, Ground Weapons, maintains oversight responsibility for 20 separate procurement programs/ projects.[4] The PM is assisted in his duties by seven Assistant PMs (APM) responsible for infantry weapons, anti-armor weapons, tank systems, fire support systems, directed energy systems, amphibious/raid systems, and maintenance. The PM, Ground Weapons, is unique among MARCORSYSCOM PMs in that he maintains a designated billet for a MANPRINT Specialist to perform human systems integration and coordination on joint Army-Marine Corps acquisition programs. The billet is manned by a Gunnery Sergeant (E-7) trained in U.S. Army MANPRINT principles and procedures. Presently, no replacement is slated to fill this billet upon its vacancy in September 1994.

Matrix support for the execution of human systems analysis is divided between two MARCORSYSCOM organizations: the Program Support Directorate (PS) and Program Manager, Training Systems (PM, SST).

The Program Support Directorate is available to the PMs for logistical, technical, and analytical expertise, service and support. Figure 3-4 diagrams the organizational structure of PS. The MARCORSYSCOM Organizational Manual P5400.1A does not formally mention or assign responsibility for human factors engineering within the PS Directorate. Instead, human factors engineering is loosely assigned to general engineers assigned within the Product Assurance and Maintenance Engineering Section of the Systems Engineering Branch. These personnel are responsible for the reliability and maintainability of selected weapons systems and equipment. The systems safety and health hazards functions are housed in the Configuration Management and Systems Safety Section. These personnel are responsible for the disciplines of systems

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[4] At the time of this research the PM, Ground Weapons, managed two ACAT I programs, eight ACAT III programs, and ten ACAT IV program.

safety engineering, safety certification, and environmental and pollution prevention.

Manpower, personnel, and training support is afforded to the PMs on an as requested basis through the Program Manager, Training Systems. Figure 3-5 illustrates the Training Systems Program Management Office's organizational structure. The Manpower and Training Branch is tasked to support the PMs by performing the following functions:

1. Validate program personnel requirements by MOS and grade through coordination with HQMC, MCCDC, and the FMF;

2. Evaluate the impact of maintenance and operational concepts on the planner number of operators and maintainers;

3. Evaluate the cost and effectiveness of the training concept;

4. Ensure that necessary personnel and equipment for schools to properly train operators and maintainers are identified;

5. Validate life-cycle training costs;

6. Ensure training development is in accordance with the MCCDC Systems Approach to Training through close coordination with MCCDC, formal schools, and the FMF in the training development process.

The Manpower and Training Branch is composed of four Training Logistical Engineering Managers (LEM), two Manpower LEMs and a Branch Head. Prior to October 1993, the Branch was an organizational sub-unit within the PS Directorate. However, in 1993, a Structure Planning Group was directed by the Commander, MARCORSYSCOM, to review program management and support offices performing like functions for possible consolidations. The Group's recommendation, which was subsequently implemented, was to reorganize the Manpower and Training Branch under the direction of PM, Training Systems.

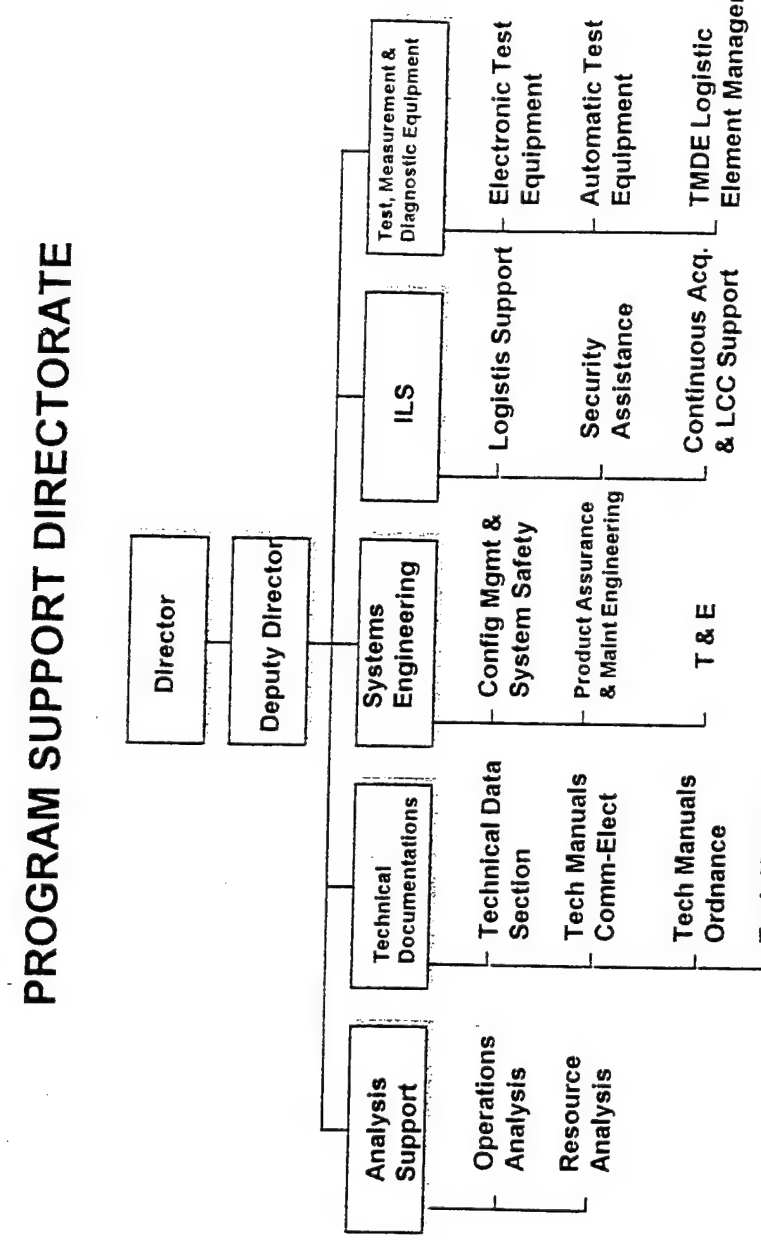

Figure 3-4 Program Support Directorate organizational structure. (MARCORSYSCOM, 1994, p. 3-19)

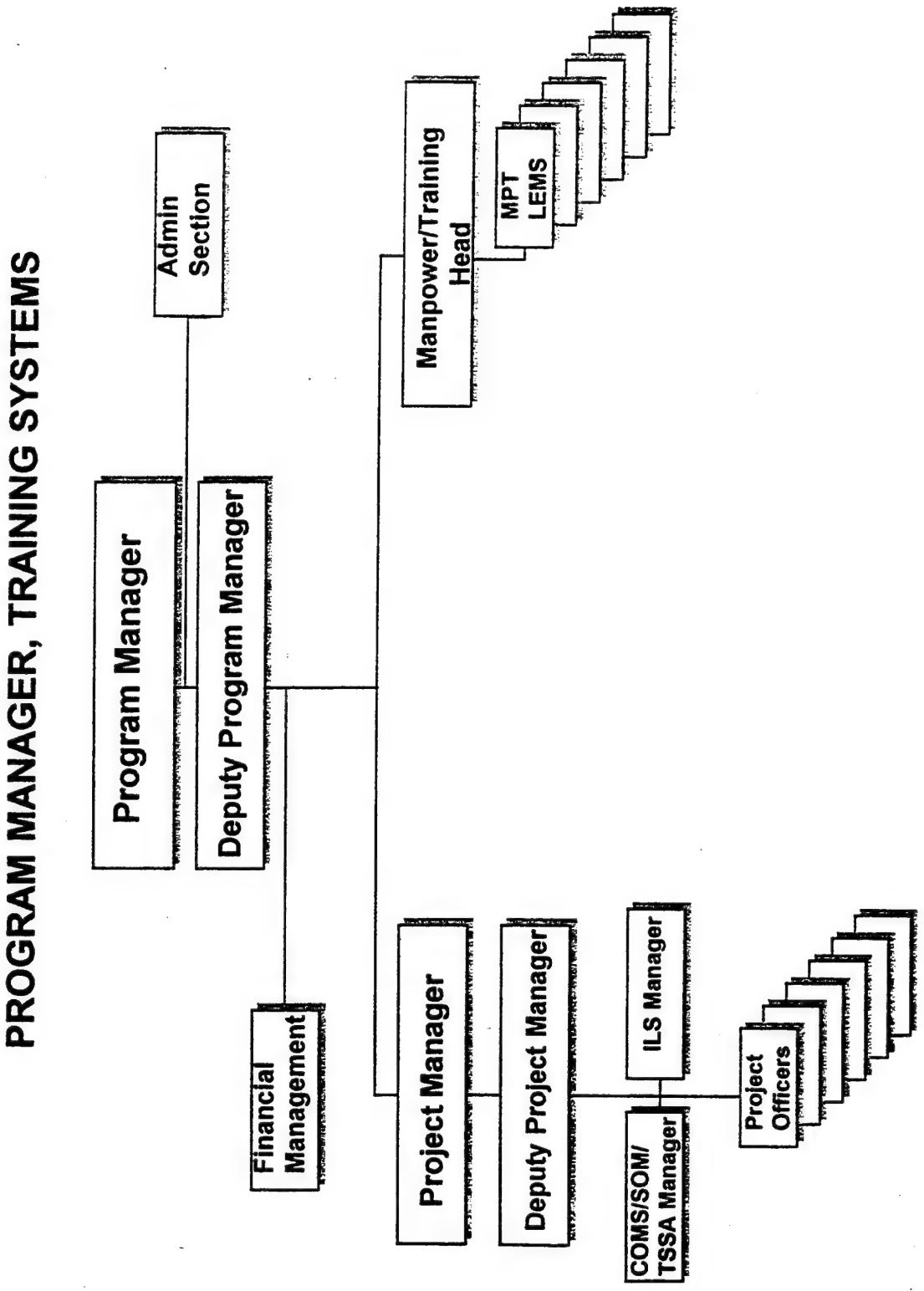

Figure 3-5 Training Systems Program Management Office organizational structure. (MARCORSYSCOM, 1994, p. 2-7)

The objective of the action was to increase the organizational emphasis on training and training systems. Thus, the Training Systems Program Office is tasked with a dichotomous mission: management of the acquisition of non-standard training equipment and performance of program MPT evaluations. To date, no effort has been made to identify or track the benefits or drawbacks resulting from this consolidation.

Despite the capabilities of the PS Directorate and the Manpower and Training Branch, the PMs are under no requirement to utilize these command assets. With the exception of Legal Council, the PMs may obtain technical support from whatever internal or external sources they deem necessary. Policy Statement No. 1-90 limits the PMs "only by their mandates to stay within approved funding and personnel ceilings; to stay within the law and the policy of higher authorities; and to use resources wisely and efficiently without duplication or conflict of interest." (CG MCRDAC, 1990 p. 1) This policy statement clearly expresses the underlying philosophy of the Marine Corps acquisition process. It states that "it is essential the Program Managers have full authority, responsibility and accountability for all aspects of their programs." (CG MCRDAC, 1990, p. 1)

D. COMBAT DEVELOPMENT PROCESS

1. Identification of Need

Once a warfighting deficiency has been assessed as requiring a material solution, a mission needs statement (MNS) is drafted by the CG MCCDC. It is then staffed, forwarded for approval to the Assistant Commandant of the Marine Corps (ACMC), and returned to MCCDC for registration in the Requirements Catalog.

At Milestone I the operational requirements document (ORD) is developed, specifically defining the system's requirements necessary to address the material deficiency. A

cost-and-operational-effectiveness analysis (COEA) is considered in the development of the ORD. Other analyses may also be required to include a reliability, availability, and maintainability analysis, a mission profile analysis, and a combat active replacement factor analysis. Drafted and staffed by the CG MCCDC, ORDs then are approved by the ACMC. An ORD provides the vehicle for the solution to enter the acquisition system at either the MARCORSYSCOM for Marine Corps funded programs or one of the Navy System Commands for Navy funded programs. CG MCCDC then works in coordination with COMMARCORSYSCOM and, for Navy programs, DC/S Plans, Policy and Operations (PP&O) for the life of the program to ensure that acquisition decisions consistently reflect warfighting requirement priorities.

SECNAVINST 5400.15 assigns responsibility of the life-cycle management of Marine Corps weapons and equipment to the COMMARCORSYSCOM. The system life-cycle originates when an acquisition program is initiated and continues until the system is retired from the inventory. Life-cycle management applies to a system over its entire life, with emphasis on strengthening early decisions which shape costs and utility. Life-cycle management includes the acquisition of additional systems, the acquisition of spare parts, configuration control of the fielded systems, modification of the systems, acquisition/modification of requisite training devices that support fielded systems, the collection and analysis of maintenance data, and disposal of the system once it is retired from inventory.

2. Acquisition Management Profile

During the period of this study, the COMMARCORSYSCOM was responsible for the acquisition of 99 systems and the modification of two existing systems. In addition, the Advanced Amphibious Assault Vehicle (AAAV) program was being conducted under direct-reporting procedures to the Assistant

Secretary of the Navy. Figures 3-6 through 3-9 graphically depict the division of current Marine Corps procurement programs by acquisition category and lead Service.

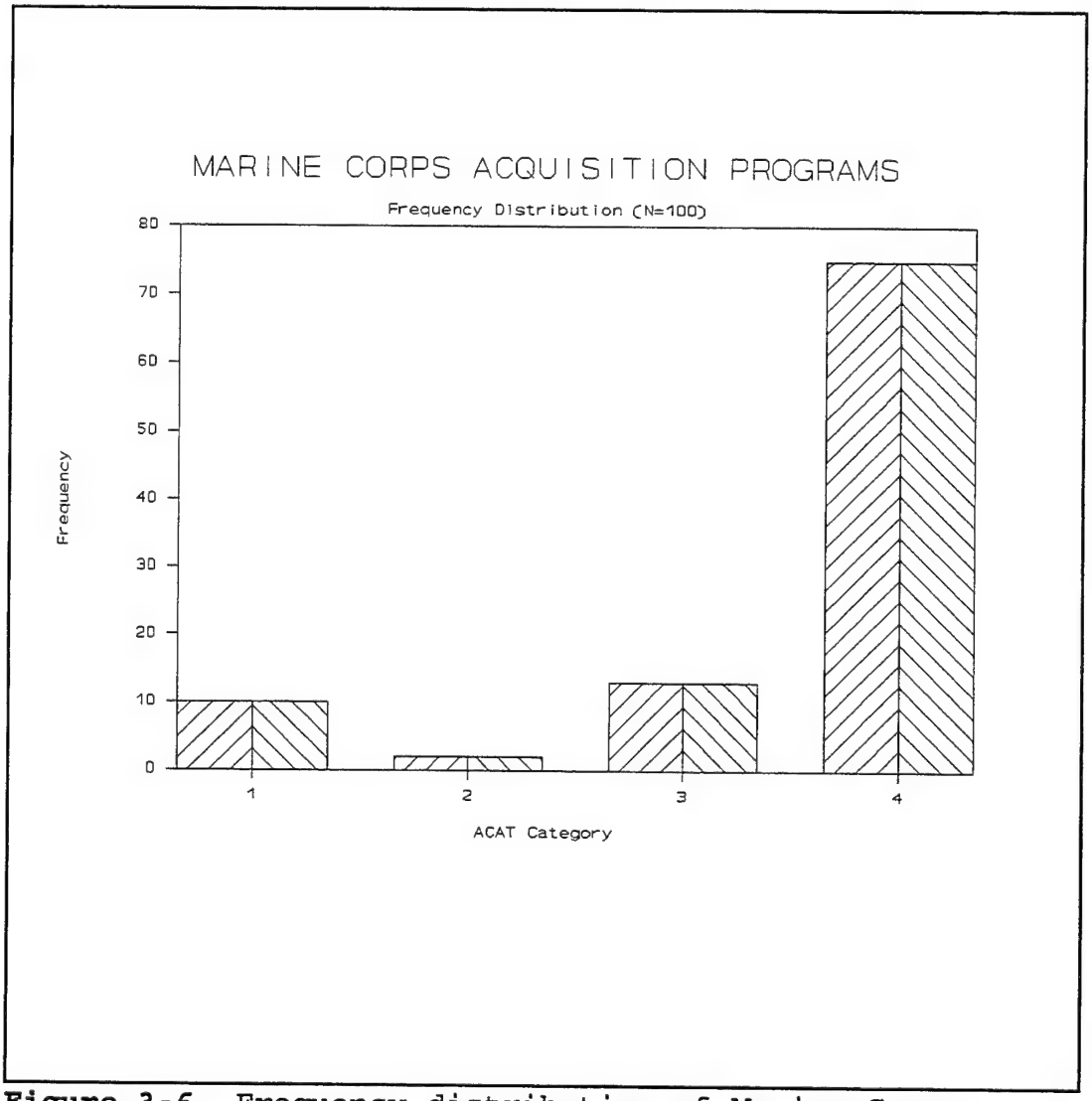

Figure 3-6 Frequency distribution of Marine Corps acquisition programs by ACAT category.

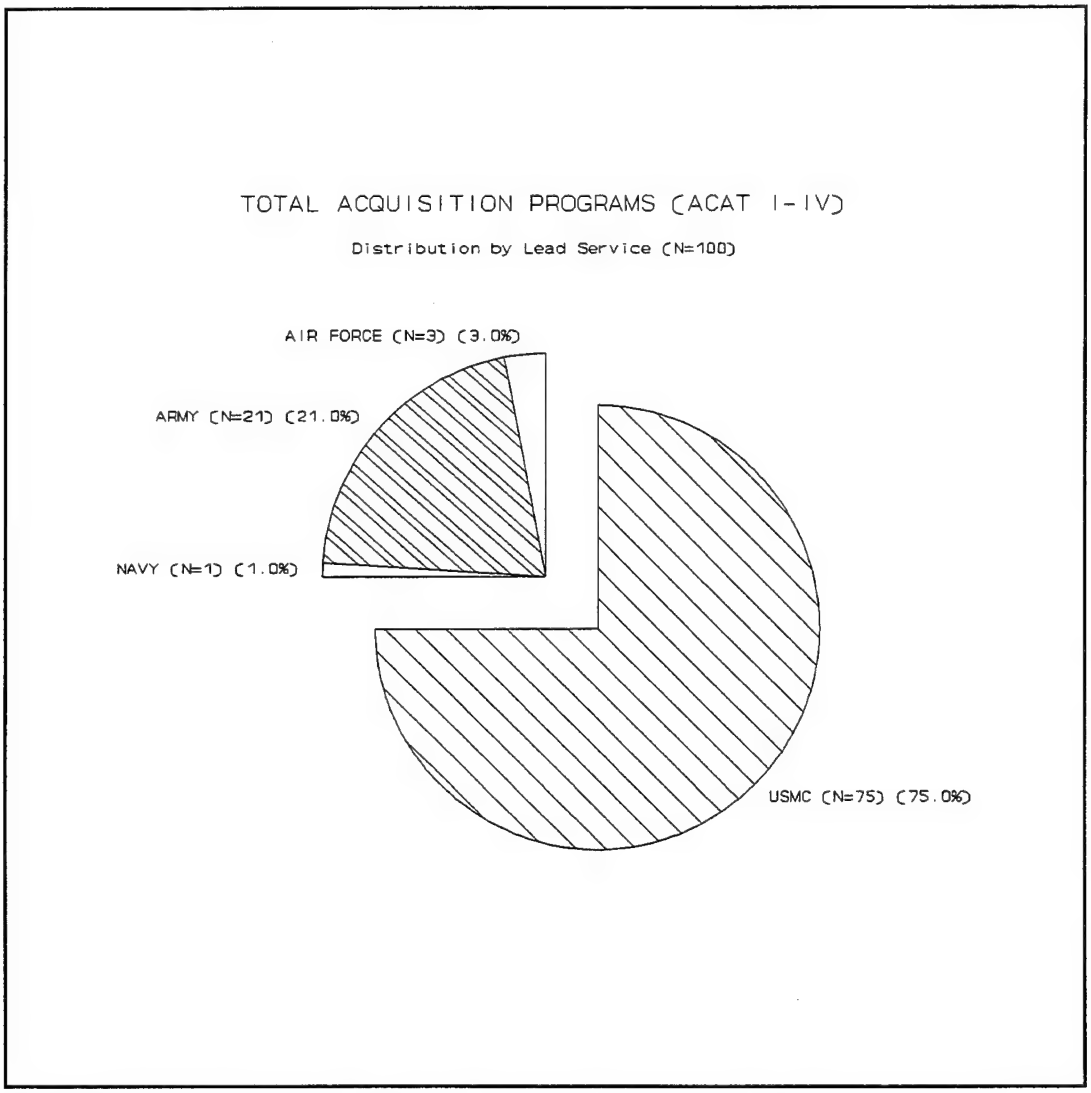

Figure 3-7 Total Marine Corps acquisition programs distributed by lead service.

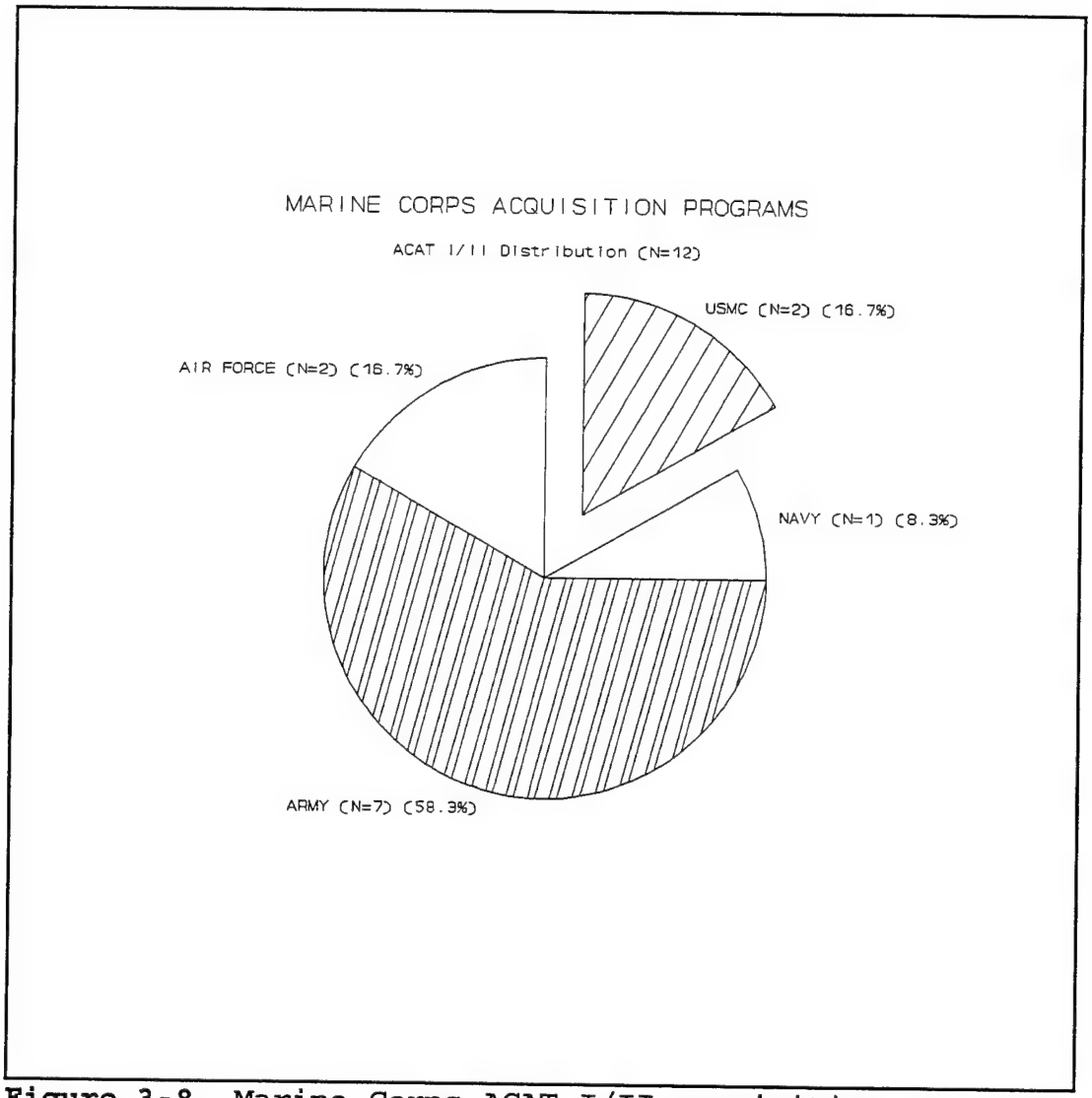

Figure 3-8 Marine Corps ACAT I/II acquisition programs distributed by lead service.

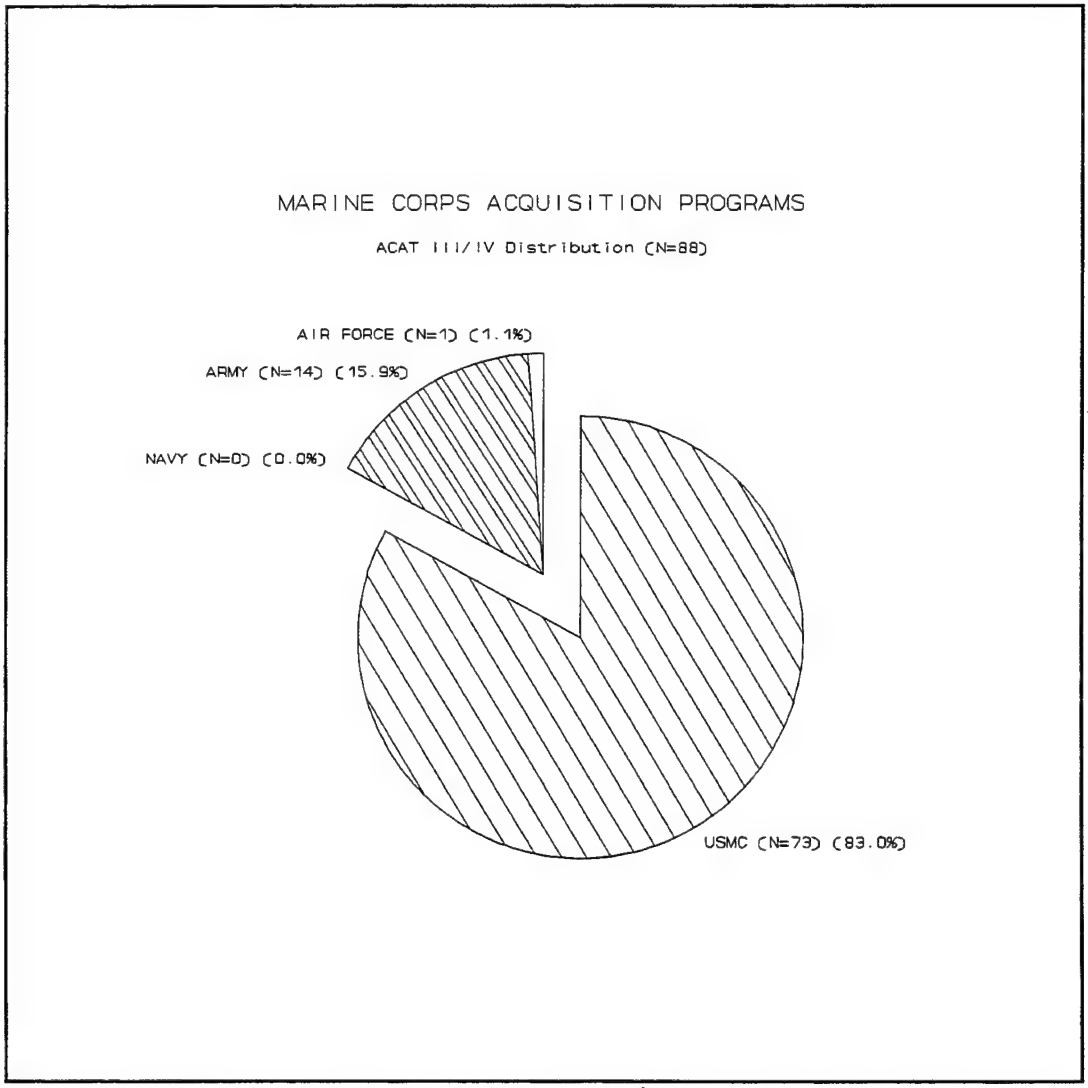

Figure 3-9 Marine Corps ACAT III/IV acquisition programs distributed by lead service.

Of special note is the fact that 21 programs are being procured by the U.S. Army as lead Service, and are thereby directed in their HSI efforts by the MANPRINT program.

3. Human Systems Integration Procedures

During the course of this research it became apparent that the Marine Corps did not possess published policies, directives, or instructions for the performance of human systems analysis. Because the organizational philosophy of MARCORSYSCOM considers each program unique, and thus allows Program Managers the authority to tailor the acquisition process to the particular needs of their programs, no HSI standard operating procedures currently exist.

Not until the publication of MCO 5000.22, "Implementation of Defense Acquisition Management Policies, Procedures, Documentation and Reports," in August 1994, did the Marine Corps clarify its implementation of the requirements set forth by DoD Instruction 5000.2 and Secretary of the Navy (SECNAV) Instruction 5000.2A. The order made no refinements to Part 7, Section B, Human Systems Integration, and therefore mandated application of HSI to all ACAT categories, I through IV. Prior to this reaffirmation of policy, the consensus among program management and support personnel was that HSI did not apply to non-major programs or was not applicable to the same degree. Hence, little or no human systems analysis was conducted on 75 current Marine Corps unique non-major procurement programs.

For programs that did implement human factors analysis, analysis and HSIP development were normally contracted to civilian contractors. The cost to the PM for an HSIP is estimated at $90,000. Since the Marine Corps operates no defense technology laboratories, the PMs are compelled to rely on other Department of Defense laboratories, such as the Naval Air Warfare Center or the Army Human Research Lab, or similar commercial facilities for the conduct of HSI research.

Presently, the Logistics Appraisal is the only review

process operated within MARCORSYSCOM to evaluate program consideration of human factors issues. Conducted prior to Milestone I, II, and III decision reviews,[5] the appraisal's stated purpose is to provide a systematic method for ensuring that logistics are adequately planned, managed, and executed during each phase of an acquisition program. Appraisals are conducted by one of two methods; the Logistics Assessment Review (LAR) or the Logistics Review Group (LRG). The LAR is a condensed appraisal conducted by the Integrated Logistics Support Management Team (ILSMT) in two to three weeks.

The LRG is a formal appraisal conducted by an independent assessment team in four to five weeks. The Logistics Review Group (LRG) is co-chaired by the Director, PS, and a representative from CMC (Logistics). The assessment team is headed by a Program Support senior logistician and consists of HQMC logistics personnel, Manpower, Personnel, and Training LEMs, Program Support engineering representatives, and Marine Corps Logistics Base, Albany, GA, support personnel,.

In the first stage of an appraisal program acquisition documentation related to logistics issues are staffed to the various members of the assessment team. The group subsequently meets to discuss, resolve, and classify the findings of their independent reviews.[6] The appraisal results in a "certification" that the program is logistically

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[5] The point when a recommendation is made and approval sought regarding starting or continuing (proceeding to next phase) an acquisition program. Milestones are 0 (Concept Studies Approval), I (Concept Demonstration), II (Development Approval), III (Production Approval), and IV (Major Modification Approval).

[6] Findings can receive one of three classifications: 1) Critical -- will cause non-certification of the program unless corrected; 2) Major -- will not cause non-certification by itself but an accumulation of these could, and 3) Minor -- errors, such as format, verbiage, typographical mistakes, minor technical errors, etc.

supportable, otherwise a Program of Action and Milestones (POA&M) is issued for the correction of deficiencies noted during the review. An executive summary is then forwarded to the Director, Program Analysis and Evaluation, for review and presentation to the Acquisition Decision Authority. In theory, failure to achieve certification due to HSI findings can halt or delay program progression in the acquisition cycle. Personal interviews and review of recent LARs, revealed no record of Milestone Approval being withheld or delayed.

As Milestone Decision Authority, the COMMARCORSYSCOM personally reviews each program prior to authorizing Milestone Approval. The PM or Project Officer presents his program's status and relevant issues at a Marine Corps Program Decision Meeting (MCPDM) prior to each milestone. Coordinated by the Director, PA&E, the MCPDM includes the presentation of an Independent Program Assessment, summarizing the program reviews performed by both internal and external agencies. MCPDM attendance is tailored according to the magnitude of the program. At a minimum, key participants typically included COMMARCORSYSCOM, the PM/PO, the PA&E Director, and the PS Director. The MCPDM provides a formal forum for the discussion of program strengths and deficiencies. The Commander's Milestone Decision and subsequent taskings are then disseminated in an Acquisition Decision Memorandum (ADM). The Director, PA&E, is responsible to conduct follow-up review to ensure the accomplishment of Commander's MCPDM taskings.

E. SUMMARY

While acknowledging the need for consideration of human issues in the acquisition process, the Marine Corps has applied limited effort to the development of an HSI program. Following the Navy's lead, the Marine Corps adopted the HARDMAN methodology to correct identified MPT deficiencies.

However, lacking further proponency by senior Marine Corps officials, the HSI program expanded only marginally beyond its initial MPT foundation, and then primarily in response to the requirements levied by DoD Instruction 5000.2.

Competing with cost, schedule, and performance, human systems integration is the responsibility of the Program Manager. MARCORSYSCOM does not maintain a consolidated HSI organization to support, supervise, or review the performance of HSI. Instead, cognizance for the HSI disciplines is divided between the Program Support Directorate and the Manpower and Training Branch. Further, PMs are under no obligation to seek nor utilize their input. Instead, human systems analysis, when applied, is accomplished through the "stove-piped" staffing of acquisition documents for review. The sole constraint imposed on Program Managers is the requirement to obtain program certification from the PA&E Directorate prior to MCPDM and Milestone Approval. Based on LAR findings and documentation reviews, certification only partially addresses the six HSI disciplines.

With only limited organizational guidance, oversight, and support, the effectiveness of the Marine Corps' HSI program is contingent on the initiative and efforts of the Program Management Office. Because of its decentralized nature, the HSI program can best be evaluated in the light of its application to specific acquisition programs. Thus, following a parallel review of the Army's MANPRINT program in Chapter IV, this thesis will analyze the AAAV and Predator programs to extrapolate generalizations on the inherent strengths and weaknesses of the Marine Corps' current HSI program.

IV. THE U.S. ARMY MANPRINT PROGRAM

A. INTRODUCTION

The U.S. Army's HSI program, MANPRINT, like its Marine Corps counterpart, was born from Congressional, DoD, and Service dissatisfaction with the inability of technologically advanced modernization efforts to achieve projected levels of performance. But, whereas the Marine Corps' HSI program was built on the framework established by DoD Instruction 5000.2, the Army's MANPRINT program was the foundation on which the DoD framework was constructed.

Prior to testing its current application, the soundness of the MANPRINT structure must first be analyzed. In developing a blueprint of the MANPRINT program, the internal and external factors which influenced its development will be outlined. Then, its current policies, procedures, and organizational infrastructure will be examined to identify its structural strengths and flaws.

B. BACKGROUND

From the 1960's through the 1980's, the Army initiated a major modernization effort in response to the Soviet Cold War threat. Hundreds of new and technologically complex weapon systems were introduced to generate increased combat power despite fiscal and manpower constraints. However, greater reliance on technology precipitated two persistent problems. First, overall system performance often failed to achieve predicted standards when employed in operational use. For example, the Dragon anti-armor missile system, which was designed for 90 percent chance of first-round hit, was actually producing only 30 to 50 percent accuracy when integrated with a soldier. Secondly, the replacement of a fielded weapon with a more technologically complex system frequently generated requirements for increased numbers of higher-skilled soldiers to both operate and maintain the

system. Consequently, the Army was compelled to recruit higher-skilled personnel, expand training programs and training funding, and increase force end-strength. In the 1960's, Dr. John Weisz, Director, U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD, identified the problem, asserting that:

> We can no longer afford to develop equipment and merely hope that the necessary manpower can be found to man it and/or be trained to man it in a relatively short time. Cost of training and, especially, time available for such training on a mass basis may not permit such selection and training under wartime conditions (Adams, 1989, p.24).

Awareness of the detrimental situation expanded throughout the 1970's. The Army Material and Readiness Command responded in November 1978 by instructing program managers and development commands to prepare human factors engineering analysis for presentation at the preliminary review of each Army Selected Acquisition Review Council (ASARC) milestone.

In 1980, Generals Walter T. Kerwin and George S. Blanchard raised concerns about mobilization, readiness, and sustainability brought on by the increases in weapons complexity. They concluded that human performance assessments were often not integrated and made too late to influence the weapons systems acquisition process. The following examples illustrate the human systems integration deficiencies confronting the Army during that period:

1. One Army division could have as many as 47 different types of generators, yet the Army had no MOS for generator mechanic;

2. The proliferation of highly sophisticated computers in new weapon systems was so extreme that the Fire Control Computer Repairmen, MOS 34G, were tasked with the maintenance of 31 different systems;

3. From 1978 to 1982, the unit manpower requirement for the Patriot air defense system had grown by over 15 percent from 608 to 705 personnel.

As initial fielding of the major modernization programs progressed, the Army personnel community experienced problems in their ability to recruit the number and quality of personnel necessary to maintain the force. While recruiting levels improved in 1980's, a need still existed to recruit more and higher "quality" people who would be able to operate and maintain the new systems with their increased automation and complexity. This demand for quality gained Congressional interest due to the funding levels required to recruit and retain such personnel.

Simultaneously, training plans associated with the new systems also showed a significant increase in the projected training necessary for both new accessions and current personnel in the transition to new systems. The resultant increase of training time caused the personnel overhead account to grow despite fixed end-strength constraints.

Congressional pressure for acquisition reform emerged from the GAO's 1981 report criticizing the Army's management and lack of progress in integrating MPT issues into the acquisition process. A Soldier-Machine Interface study and several Army Science Board studies reconfirmed these results and provided an additional impetus for change.

C. MANPRINT PROGRAM IMPLEMENTATION

In 1982, General Maxwell R. Thurman, Deputy Chief of Staff for Personnel (DCSPER), directed the U.S. Army Research Institute to investigate the development process of several previously fielded weapon systems and conclude what the Army could have done differently to better integrate manpower and training issues. The initiative, known as the Reverse Engineering Project, studied the development of four systems:

1) the Pedestal-Mounted Stinger (PMS); 2) the UH-60 Black Hawk helicopter; 3) MLRS, and 4) MI BITE. The evaluation demonstrated that the integration of manpower, personnel, and training (MPT) issues early in the design process could have made a significant difference.

Armed with these findings, General Thurman initiated the MANPRINT[7] program to accomplish integration: "We must make smart decisions by considering the man-in-the-loop, early and continuously in the material acquisition process." In 1983, an Army Science Board task force was commissioned to determine how people issues should be integrated into the acquisition process. They initially recommended six areas of human systems considerations or "domains" for the program. Four of these, human factors engineering, manpower, personnel, and training, were directed at enhancing soldier performance The remaining two, health hazards and system safety, were targeted to prevent degradation of soldier performance.

Since its inception, the MANPRINT program has expanded its roles and responsibilities within the Army acquisition process. In 1991, responding to numerous complaints that such Automated Information Systems (AIS) were not being designed to maximize soldier-system performance, the Army included such systems under MANPRINT management.

The lessons learned from Operation Desert Storm prompted the Army to establish a seventh domain: soldier survivability. Incidence of fratricide, as well as the increases in enemy detection and recognition capabilities, and the expanding lethality and range of modern weaponry reaffirmed the requirement to enhance soldier survivability. The Army Chief of Staff, General Gordon R. Sullivan, stated that the Service

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[7] The term "MANPRINT" was created by General Richard H. Thompson, CG, AMC, in 1984. Prior to that time, soldier-machine interface (SMI) or human factors, manpower, personnel, and training (HMPT) were used to refer to the general issue.

could not accept casualties which could be prevented by proper research, development, and acquisition. In 1992, the DCSPER, Lieutenant General Thomas P. Carney, officially instituted soldier survivability as the seventh MANPRINT domain.

The Army MANPRINT program continues to evolve as new HSI policies and procedures are implemented or refined. Espousing its firm commitment to human systems integration, the Army, through the efforts of the MANPRINT Directorate, actively seeks to expand the use of the MANPRINT philosophy throughout DoD. A 1994 report published by the Hay Group, under contract to the MANPRINT Directorate, stated that the Army followed a strategy which utilized organizational bureaucracy to institutionalize the program and build in resiliency. (Blackwood, 1994, p. 20) To this end, the report stated, the Army reassigned its lead MANPRINT Action Officer, Colonel Blackwood, to the Strategic Planning Office of the Under Secretary of Defense (Acquisition). During the course of this assignment, the report asserted, he lobbied the OSD manpower community which eventually lead to the publication of DoD Directive 5000.53,"Manpower, Personnel, Training and Safety (MPTS) in the Defense System Acquisition Process," on 30 December 1988. The directive mandated that each Service have an HSI program.

Nina Richman-Loo, a former MANPRINT practitioner and current Program Analyst, HSI Division, OSD, contests this conclusion. She attributes the emergence of a defense-wide HSI program to several other factors. These factors include the recommendations of the senior human factors technologist in the Defense Research and Engineering Directorate, the Congressional requirement for Manpower Estimate Reports for major defense systems, and the receptiveness of FM&P senior officials to adopt a new mission that addressed human interfaces in defense systems acquisition. In addition, the newly established "Manpower, Personnel, Training and Safety"

program took its Congressional mandate and expanded upon it to provide an umbrella for the Service HSI organizations which all addressed MPTS to some degree. While acknowledging Colonel Blackwood's positive influences, she contends that the MANPRINT model was adopted by DoD because it was the only viable program at that time. "The Navy did not have a program, and IMPACTS (Air Force) was struggling, so MANPRINT was chosen as the foundation for the DoD HSI program," she said. A Marine Corps HSI practitioner summarized the action by stating, "Basically, DoD took the Army's MANPRINT program, painted it purple, and republished it as part of the 5000 Series."

D. THE MANPRINT PROGRAM

1. Conceptual Overview

MANPRINT is a comprehensive management and technical effort designed to optimize total system performance by focusing on soldier performance and equipment reliability. MANPRINT seeks to influence systems design throughout the acquisition process by coordinating efforts to ensure that a cost-effective, safe, operable, maintainable, and reliable system is developed within the constraints of available human and economic resources. An iterative process tailored to the nature of the acquisition program, MANPRINT endeavors to achieve the following objectives:

1. Enhance the operational effectiveness of the total system;

2. Influence soldier-material system design for optimum total system performance;

3. Ensure systems, through their employment, conform to the capabilities and limitations of the soldier;

4. Assist the Army trainer in determining, designing, developing, and conducting sufficient/necessary training;

5. Improve control of life-cycle costs of soldier-material systems;

6. Provide MANPRINT data for the development of required technical manuals and training devices;

7. Ensure that system engineering is consistent with safety and health standards.

To do so, MANPRINT continuously integrates seven human factors consideration or "domains" throughout the material acquisition cycle. The seven current domains are:

- Manpower: The number of human resources, both men and women, military and civilian, required and available to operate and maintain Army systems.

- Personnel: The aptitudes, experiences, and other human characteristics necessary to achieve optimal system performance.

- Training: The requisite knowledge, skills, and abilities needed by the available personnel to operate and maintain systems under operational conditions.

- Human Factors Engineering: The comprehensive integration of human characteristics into system definition, design, development, and evaluation to optimize the performance of human-machine combinations.

- System Safety: The inherent ability of the system to be used, operated, and maintained without accidental injury to personnel.

- Health Hazards: The inherent conditions in the operation or use of a system (e.g. shock, recoil, vibration, toxic fumes, radiation, noise) that can cause death, injury, illness, disability, or reduce job performance of personnel.

- Soldier Survivability: The characteristic of a system that can reduce fratricide; as well as reduce detectability of the soldier; prevent attack if detected; prevent damage if attacked; minimize medical injury if wounded; and reduce physical and mental fatigue.

While traditional design approaches addressed human

considerations after technological development, MANPRINT places the soldier and his needs into the systems acquisition loop from the start. Figures 4-1 and 4-2 contrast the traditional and MANPRINT methodologies. To optimize total system performance, MANPRINT seeks to identify and execute trade-offs between and among the performance variables early and continuously in the acquisition cycle. However, to achieve this goal and ensure effective man-material interface, MANPRINT must be accorded equal priority with all other system characteristics, such as technical management and cost. Ultimately, the essence of MANPRINT is found in the ability of the Army and industry to answer the question: Can this soldier with this training perform these tasks to these standards under these conditions?

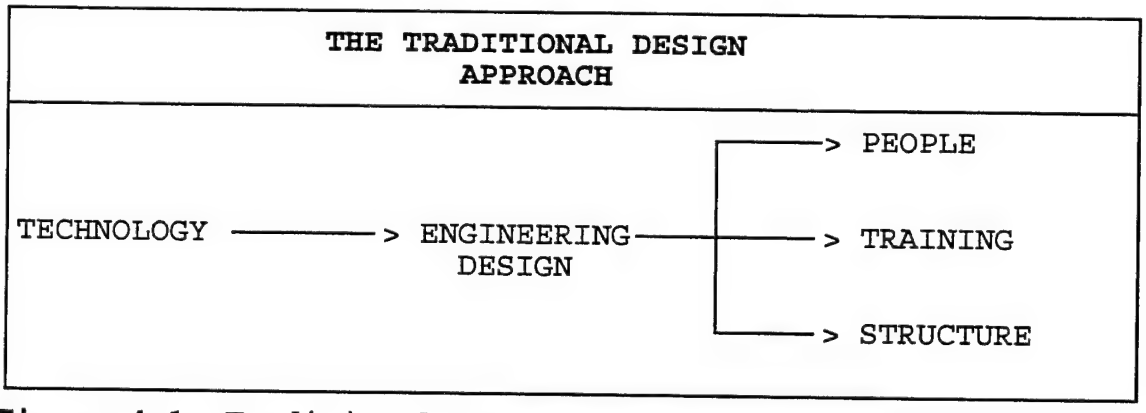

Figure 4-1 Traditional systems design approach.

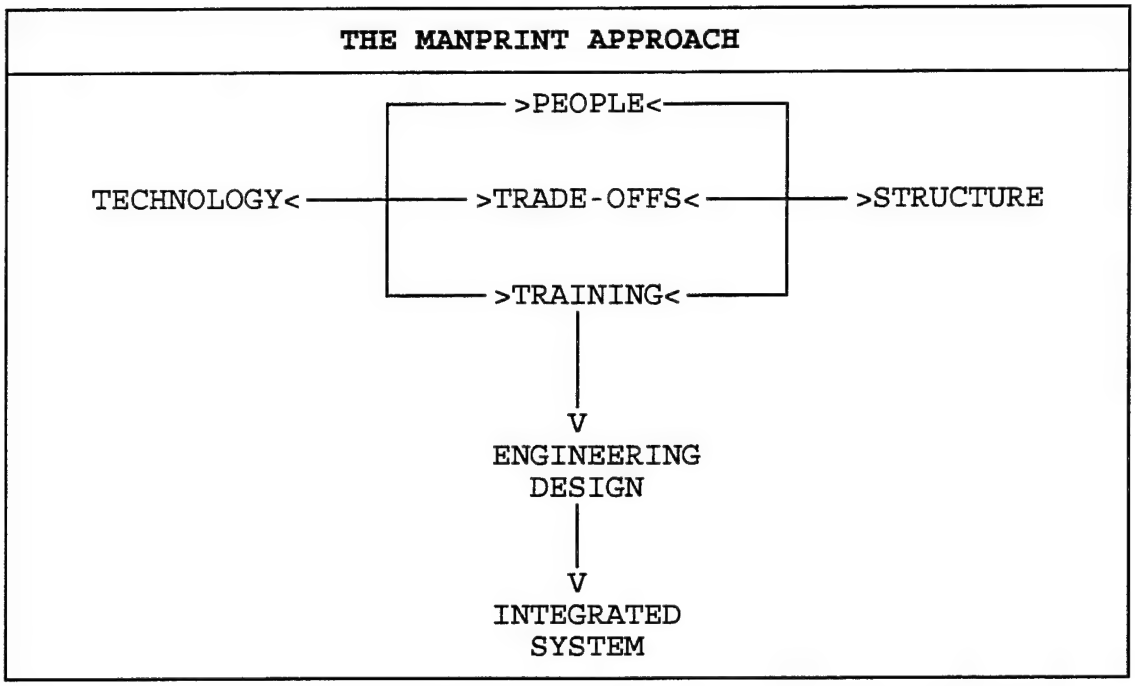

Figure 4-2 MANPRINT approach to defense systems design.

2. Organizational Structure

To achieve its ambitious HSI objectives, the Army has developed an elaborate network of MANPRINT support organizations. The organizational structures, responsibilities, and relationships which govern the MANPRINT program are outlined in Army Regulation 602-2, "Manpower and Personnel Integration (MANPRINT) in the Material Acquisition Process," and will be reviewed in this section.

The inclusion of MANPRINT into the acquisition process begins with the Program Executive Officers. The PEOs are tasked to include in all PM charters the responsibility for executing the MANPRINT program. PEOs are required to monitor and rate the PMs execution of MANPRINT responsibilities and to subsequently consider the rating in performance appraisals. By establishing institutional mandates and incentives for HSI, the Army expands the PMs responsibilities beyond the traditional parameters of cost, schedule, and performance.

Direct responsibility for the implementation, support, and execution of the MANPRINT effort is assigned to the Project/Product Managers. Among the PM's responsibilities are the following:

1. Provide adequate support for effective MANPRINT effort implementation and maintenance;

2. Initiate requests for the conduct of MANPRINT domain assessments;

3. Conduct MANPRINT reviews to determine the status and adequacy of MANPRINT efforts;

4. Annotate the status and adequacy of MANPRINT efforts in program documents and brief at milestone decision reviews;

5. Establish MANPRINT as a separate major area in the source selection process.

To perform the myriad of assigned MANPRINT functions, the PM is tasked to provide a MANPRINT manager. Typically, an Assistant PM (APM) is assigned joint responsibility for logistics and MANPRINT.

Within the Department of the Army Headquarters responsibilities are distributed to the following offices:

- Assistant Secretary of the Army (Manpower and Reserve Affairs) (ASA(MRA));
- Assistant Secretary of the Army (Research, Development, and Acquisition) (ASA(RDA));
- Director of Information Systems for Command, Control, Communications, and Computers (DISC4);
- Deputy Chief of Staff for Logistics (DCSLOG);
- Deputy Chief of Staff for Intelligence (DCSINT);
- The Surgeon General;
- Deputy Chief of Staff for Operations and Plans (DCSOPS);

- Deputy Chief of Staff for Personnel (DCSPER);

While it is beyond the scope of this thesis to review the MANPRINT responsibilities of each of these organizations, it is essential to understand the functions of the DCSPER office.

The Deputy Chief of Staff for Personnel holds primary Department of the Army staff responsibility for the MANPRINT program. Supported within his command by the MANPRINT Directorate, the DCSPER develops, coordinates, and disseminates MANPRINT program policy and guidance to all Army commands and agencies. This includes approving policy, guidance, and formats for all MANPRINT related documents. Charged to ensure that MANPRINT is addressed early and continuously in the development of total system performance requirements, the DCSPER exercises oversight responsibilities of the MANPRINT efforts for all major and Level I non-major acquisition programs. In this capacity, the DCSPER prepares MANPRINT assessments in preparation for milestone decision reviews. The assessment responsibilities of the DCSPER will be covered in greater detail in subsequent sections.

Other major Army commands (MACOM) crucial to the execution of the MANPRINT program are the Training and Doctrine Command (TRADOC) and the Army Material Command (AMC). The MANPRINT process is initiated by the Commanding General, TRADOC. As the combat developer representing the needs of the operational end-user, the CG, TRADOC, is required to ensure that requirements documents include adequate specification of MANPRINT requirements. To accomplish this objective, a MANPRINT Joint Working Group (MJWG) is established by the proponent school or center three to six months prior to the operational and organizational plan. TRADOC then coordinates and provides MANPRINT information to the material developer for execution in all material programs. This includes documenting in the System MANPRINT Management Plan (SMMP) the

requirements for material developer's MANPRINT related efforts such as MPTS descriptions, human factors engineering assessments, health hazard assessments, and logistic support analyses. The SMMP and MJWG will be discussed in detail later in this chapter.

Representing system operators and maintainers, the CG TRADOC is responsible for inputing into the acquisition process population data on the system's users and maintainers. Therefore, CG, TRADOC, is tasked with the following responsibilities:

1. Develop target audience descriptions for use by combat, training, and material developers and contractors;

2. Ensure that MANPRINT data is collected during user testing for which TRADOC is responsible;

3. Provide support to AMC in developing and maintaining the automated MANPRINT data base;

4. Prepare Manpower, Personnel, and Training input to MANPRINT assessments and reviews.

As the representative for the Service's schools, the Commanding General is tasked with conducting MANPRINT training for Army Staff agencies and major Army commands, as well as ensuring that MANPRINT concepts are applied to training and training systems. Employment and doctrinal decisions made by TRADOC are required to be analyzed for resource and human performance implications. Finally, CG, TRADOC, provides assistance to AMC in the preparation of MANPRINT assessments on non-major level II and III programs in preparation for milestone decision reviews.

As the material developer, the Army Material Command procures material systems to satisfy operational requirements identified by the combat developer. As such the CG, AMC, is directly responsible for the implementation of MANPRINT policies and procedures at the program level. Hence, the CG,

AMC, assumes numerous MANPRINT responsibilities to include the following:

1. Develop, coordinate, and implement standards and procedures for all MANPRINT domains in all material and training device designs;

2. Ensure that MANPRINT training is provided to all Project, Program, and Product Managers, as well as all scientists, engineers, and contract management personnel involved in the development process;

3. Include MANPRINT as a separate major area in the source selection process;

4. Provide the MANPRINT manager for all AMC-developed material systems;

5. Ensure that technical trade-off analyses include human performance and reliability considerations;

6. Develop human factors approaches, methodologies, and models;

7. Fund contracted MANPRINT studies and methodologies and ensure that ODCSPER approved MANPRINT methodologies have been applied to appropriate systems;

8. Provide system safety assessment and management input to MANPRINT assessments throughout the life-cycle of material system development and acquisition.

Acting in the capacity of DCSPER for non-major programs, AMC is further responsible for the preparation of MANPRINT assessments for post-Milestone I Decision Reviews.

To fully comprehend the roles and responsibilities of the above listed organizations, it is necessary to trace the MANPRINT process from its initiation by the combat developer through final milestone decision approval by the ASARC.

3. The MANPRINT Process

The nucleus of the MANPRINT process is the MANPRINT Joint Working Group (MJWG) which is formed and initially chaired by the combat developer at the outset of any program. MJWG membership is tailored by the proponent combat developer based

on the nature of the program. As a minimum, a MJWG will have an expert from each MANPRINT domain and representatives for the material developer.[8] The role of the MJWG is to develop and maintain the System MANPRINT Management Plan (SMMP). Throughout the acquisition process, the MJWG identifies and manages MANPRINT issues, while providing oversight to ensure that MANPRINT is carried out.

The SMMP is a planning and management guide which documents MANPRINT goals, constraints, concerns, and questions throughout the acquisition process. By identifying required HSI tasks, analyses, trade-offs, and decisions, the SMMP provides continuity to the MANPRINT effort. It produces a formal audit trail which tracks MANPRINT issues throughout development and fielding. The SMMP is the only MANPRINT source document and record. Appendix F presents a generic System MANPRINT Management Plan format.

The SMMP is initiated by the combat or training developer when the Mission Area Analysis (MAA) identifies a battlefield deficiency requiring the development of new or improved material. A living document, the SMMP is continually revised and updated as changes emerge, a system's design progresses, and/or system trade-offs are made. For the Army, the SMMP fulfills the requirements delineated in DoD Directive 5000.2 for the Human System Integration Plan.

During source selection, the Army mandates that "MANPRINT will be a separate major area of the same visibility as technical, management, and cost and will be evaluated

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[8] Suggested membership for the MJWG includes representatives for the following organizations: 1) Combat Developer; 2) TRADOC System Manager; 3) Training Developer; 4) Safety Office; 5) Director of Evaluation and Standardization; 6) Proponency Office(s); 7) Preventive Medicine Service; 8) Human Engineering Laboratory; 9) MATDEV ILS/MANPRINT Manager; 10) Army Research Institute; 11) Supporting Proponent School, and 12) Deputy Chief of Staff for Personnel Integration, U.S. Army Total Army Personnel Command.

throughout all aspects of design, development, integrated logistics support, and program management" (AR 602-2, 1994, p. 12). MANPRINT requirements are required to be addressed in the system's statement of work and specifications. The specifications are to describe how the system is to look and act to the user and how the requirements will be verified. Offerors are instructed to address MANPRINT in every applicable portion of their offers. Further, all Requests for Proposals (RFP) require the submission of a MANPRINT Management Plan as part of the contractor's proposal.

To determine the status and adequacy of MANPRINT efforts MANPRINT reviews and assessments are conducted in accordance with DoD Directive 5000.53 and Army Regulation 70-1, "Systems Acquisition Policy and Procedures." Initial program review for both major and non-major programs is the responsibility of the applicable program sponsor.[9] In the review process, critical human issues are identified and discussed for each domain. Conclusions are then drawn and solutions are recommended as required. MANPRINT review results are documented in the program decision documents and subsequently briefed at the Milestone Decision Review.

A MANPRINT assessment is also performed for all programs prior to Milestone Decision Review. The objective of the assessment is two-fold: 1) determine the status and adequacy of MANPRINT efforts, and 2) present any unresolved MANPRINT issues or concerns to the decision-makers at the appropriate decision points. In performing an assessment, the assessor reviews the pertinent MANPRINT documentation for inconsistencies, incorrect assumptions, unresolved questions, or glaring errors. Identified issues are then classified as either positive, critical, or major based on their projected

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[9] For ACAT I and II programs, the Program Manager is responsible for the MANPRINT review. For ACAT III and IV programs, the Project Officer conducts the review.

impact.[10] Each domain is then assigned a color code, red, amber, or green, according to the severity and/or abundance of issues.[11]

The ODCSPER, supported by the MANPRINT Directorate, is responsible for the preparation of the MANPRINT assessment for all major and Level I non-major defense programs, as well as Army-designated acquisition programs. The first step in the assessment process is the production of domain reports, which are consolidated into a MANPRINT Integration Report by Human

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[10] MANPRINT observation categories:

Positive	An accomplishment attributable to MANPRINT in action and supports the MANPRINT community mission.
Critical	An issue which is highly likely to degrade operational mission performance or place a serious burden on Army resources.
Major	An issue which is moderately likely to either degrade operational mission performance or place moderate burden on Army resources.

[11] MANPRINT color codes:

Red	A domain contains a critical issue or a combination of major issues and concerns, which, taken in concert are highly likely (greater than 50 percent probability) to produce the same effect as a critical issue.
Amber	A domain contains a major issue of a combination of concerns which, taken in concert, are highly likely to produce the same effect as a major issue.
Green	A domain contains no issues or concerns, or one or several concerns exist which, taken in concert, are unlikely to produce the same effect as a major issue.

Research Engineering Directorate (HRED), Army Research Laboratory.[12] The Office of the Deputy Chief of Staff for Plans, Force Integration and Analysis within the U.S. Total Army Personnel Command then prepares a MPT Force Level Assessment. The assessment is based on the evaluation of program documentation and discussions with subject matter experts to include the system MJWG. The process culminates with the development of a system MANPRINT Assessment by the MANPRINT Directorate, DCSPER.

For non-major programs, acquisition categories III and IV, responsibility for the assessment is delegated to HQ, AMC, TRADOC, or applicable MACOMs. Figures 4-3 and 4-4 depict the organizational responsibilities for the conduct of MANPRINT reviews and assessments.

The final decision on MANPRINT issues is delivered during the Army Systems Acquisition Review Council's Milestone review of each major program. Modeled after the Defense Acquisition Board (DAB), the ASARC is co-chaired by the Army Acquisition Executive (AAE), the Assistant Secretary of the Army for Research, Development, and Acquisition (ASARDA), and the Vice Chief of the Army. Council membership is tailored according to program issues, with representatives selected from the DA and Secretariat staffs. One year prior to the review, an ad-hoc working committee is chartered to identify issues, and establish the ASARC calendar and agenda. During the following year, pre-briefings and a pre-ASARC are conducted to develop and hopefully remedy program issues.

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[12] The following organizations are responsible for producing domain assessment reports: 1) TRADOC reviews MPT issues; 2) HRED reviews human engineering issues; 3) the Army Environmental Hygiene Agency (AEHA) reviews health hazards; 4) the Army Safety Center (ASC) reviews system safety, and 5) the ARL Survivability/Lethality Analysis Directorate (SLAD) reviews soldier survivability issues.

MAJOR & LEVEL I NON-MAJOR SYSTEMS

	<-- MS I -->	MS II --> V
MANPRINT REVIEWS	Program Sponsor	PEO
	ASARC	ASARC
MANPRINT ASSESSMENTS	HQDA ODCSPER	HQDA ODCSPER
	ASARC	ASARC

MANPRINT REVIEWS
Prescribed by AR 602-2: PM has discretion on how the review is conducted. Can task proponents and/or MSCs for data/input.

MAJOR SYSTEM
Program sponsor is Material Developer until designation of PM. Functional review presented at ASARC to include MANPRINT; no prescribed format.

MANPRINT ASSESSMENT
Directed by AR 602-2.

ODCSPER coordinates input from the six domains for presentation at ASARC. U.S. Army Personnel Integration Command does MPT Assessments from available data.

Figure 4-3 MANPRINT reviews and assessments for major and level I non-major systems. (AR 602-2, 1994, p. 15)

NON-MAJOR SYSTEMS LEVEL II & III

MS I --> V

Program Sponsor

MANPRINT REVIEWS

IPR Review

HQ, AMC

MANPRINT ASSESSMENT

IPR Review

MANPRINT REVIEWS	**NON-MAJOR SYSTEM**
Prescribed by AR 602-2; PM has discretion on how review is conducted.	Program sponsor is Material Developer until designation of PM. PM presents functional review at IPR; no prescribed format.
MANPRINT ASSESSMENT	
Directed by AR 602-2.	HQ, AMC to assess all six domains for MS reviews with TRADOC input on MPT.

Figure 4-4 MANPRINT review and assessment for non-major level II and III systems (AR 602-2, 1994, p. 15).

Unresolved or critical concerns are ultimately forwarded to the ASARC for settlement.

At the ASARC, council members are given the opportunity to "vote" or air concerns about the program. A regular member of the ASARC, the DCSPER represents the MANPRINT domains. He

is responsible for highlighting major outstanding HSI concerns. Although the AAE holds the final decision authority, the opinions and recommendations of the council members are weighed before granting Milestone Approval. If an issue is deemed critical, the AAE, on the advice of his council members, may withhold approval. Otherwise, the AAE may authorize conditional approval based on the Program Manager's timely and adequate resolution of remaining issues.

4. Program Implementation

In contrast to the Navy's HARDMAN program, MANPRINT provides an excellent case study of effective HSI program institutionalization. Accordingly, a synopsis of the procedures employed by the Army in implementing and sustaining the MANPRINT program is provided in the following section. This review is intended to acquaint the reader with the critical factors necessary to institutionalize a successful HSI program.

Although many documented examples supported the idea and need for human systems integration, the MANPRINT program was nonetheless initially confronted by organizational reluctance to embrace its concepts. The first obstacle encountered was the traditional incentive for Program Managers to sacrifice long-term life-cycle costs (ownership costs) to achieve short-term acquisition cost (capital investment) savings. Rewarded for advancing systems within tight schedule and cost constraints, many PMs viewed MANPRINT as an unnecessary increase to R&D and investment costs, and a roadblock to timely fielding.

Bureaucratic entrenchment was the second obstacle MANPRINT encountered. Acquisition personnel feared that MANPRINT would create a large policy organization resulting in a "paperwork bureaucracy" rather than actually changing the Army's approach to acquisition policy. Within the bureaucracy, controversy arose as organizations perceived

MANPRINT as an infringement on their areas of responsibility. Safety activities regarded MANPRINT as a potential competitor. The integrated logistics support (ILS) community fought implementation by claiming that what MANPRINT sought to influence was already performed by the existing ILS program. Further, there was resistance to allowing the personnel community, which previously had not been an active player in the acquisition process, a means to influence systems decisions. "Overall, the various 'ilities' of the acquisition process had been in competition so long they found it difficult to combine to form an interdisciplinary approach which worked for a common goal." (Blackwood, 1994, p. 4)

The MANPRINT program next encountered opposition to the inclusion of MANPRINT requirements into Requests for Proposal and source selection criteria. As the single document which represents the government's requirements to industry, the RFP was acknowledged as the foundation of any successful MANPRINT implementation efforts. From the outset, industry made it clear to the Army leadership that if MANPRINT procedures were a requirement in the RFP they would respond accordingly. However, implementation problems arose because the Army's RFP review process was not well understood or disciplined. For example, a review of the RFP for the Light Helicopter Experimental (LHX) revealed that approximately 30 percent of the known and approved system requirements were not included into the RFP (Blackwood, 1994, p. 17). The Army recognized that the RFP had to: 1) incorporate MANPRINT tasks in the statement of work; 2) include deliverables for those tasks, and 3) list MANPRINT as a factor in source selection. Recognizing that "if there is no MANPRINT in the RFP, then there is no MANPRINT," the Army enacted regulations mandating the inclusion of MANPRINT requirements into RFPs (Blackwood, 1994, p. 17).

The inclusion of MANPRINT in source selection provoked

greater debate since it directly affected industry, expended resources, and restricted the authority to waive the requirement. As a result the acquisition community forecasted that MANPRINT would increase program costs even though there was little evidence or support from industry on this contention. The projected operating budget savings, though, were not challenged. Ultimately, the controversy required the intervention of senior leaders, who chose to enforce the inclusion of MANPRINT in the source selection process.

A 1989 study by the British Army identified six key factors in the MANPRINT program's success. The factors included: 1) organizational commitment; 2) training and education; 3) industry involvement; 4) enforcement of MANPRINT concepts; 5) early influence in the acquisition process, and 6) the development of analytic research tools.

The first and most important component of the program's success was senior officer commitment to the mission of MANPRINT. The British study cited that to successfully establish a MANPRINT program "there must be at least one very senior officer who has real influence in the acquisition process to take responsibility for the MANPRINT domains, and who also has staff to ensure assessments and trade-offs are made at the appropriate times." (Wolverson, 1989, p. 3)

The efforts Generals M. R. Thurman and R. M. Eaton, who served successively as DCSPER, were instrumental in the institutionalization of MANPRINT. "The personal interest by the DCSPER in 'marketing' the program ensured that the program had a visible champion" (Blackwood, 1994, p. 13). However, by the fall of 1985, the need for a Senior Executive Service (SES) civilian to promote the MANPRINT effort was recognized. It was determined that a high level civilian would provide continuity and visibility to both the Army and industry . Dr. Harold R. Booher, an engineering psychologist, formerly with

the Nuclear Regulatory Agency, was chosen to head the MANPRINT Directorate. To date, the MANPRINT program continues to enjoy strong advocacy from the Army's senior leaders, as evidenced in the course of this research.

To derive and sustain support from within the acquisition community, several pilot programs were selected to display MANPRINT's potential. The key pilot program was the Light Helicopter Experimental (LHX), retitled the Comanche. This project was selected because of its visibility, need, and industry involvement. The selection of the Army's most visible program to initiate MANPRINT demonstrated to the acquisition work-force the tremendous commitment of the key senior leaders. In conjunction, an active campaign was implemented to inform other senior leaders of MANPRINT's activities and accomplishments.

The second key to MANPRINT's successful establishment was Service-wide training and education. The MANPRINT Directorate confronted the problem of educating the Army and making sure that the program was understood. MANPRINT training courses were developed to inform key players from both Army and industry as to what their individual responsibilities were.

The first MANPRINT Staff Officer Course (MSOC) was conducted in January 1986. The course was expanded in 1987 to include specific training for General Officers and SES civilians, as well as mid-level managers. Military graduates of the three-week MSOC course received an additional skill identifier so they could be tracked for future acquisition-related assignments and career development.

The Army currently offers three courses: a nine-day MANPRINT Action Officers Course, a two-day MANPRINT for Managers Course, and a four-day MANPRINT Major Automated Information Systems Review Council Course. Resident and mobile training team (MTT) courses are taught by the Army Logistics Management School, Fort Lee, VA. MANPRINT training

is also extended to industry representatives.

A deliberate attempt was made to communicate with all Army personnel about the MANPRINT program. A monthly MANPRINT Bulletin was established and published starting in July 1986. In addition, MANPRINT Practitioner Conferences are held annually, and MANPRINT Point-Of-Contact lists are published quarterly. To communicate its message to the general public, the MANPRINT Directorate also actively seeks press coverage.

The third critical element was industry involvement. The Army regards MANPRINT as an Army-industry partnership. To ensure that soldier considerations are incorporated at the earliest phases of system development, MANPRINT is included in systems requirements documents and the source selection and design processes as detailed earlier. U.S. defense industries are growing increasingly aware of the MANPRINT requirements and have adapted to meet them.

The fourth key point in the successful implementation of the MANPRINT program was enforcement. The British study asserts that the process must be made mandatory to ensure initial compliance and promote institutionalization. Utilization of MANPRINT is mandated by AR 602-2, and echoed in DoD's HSI requirements set forth in DoD Instruction 5000.2. However, it is enforced by the authority of the DCSPER, as a member of the ASARC, to present MANPRINT issues before the council and to vote against Milestone Approval if MANPRINT concerns are not adequately addressed.[13]

The British study also recognizes that the MANPRINT process must be initiated early on in the acquisition cycle to most cost-effectively influence system design. "Front-end analysis" is a fundamental tenet of both the Army's MANPRINT

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[13] While not negatively impacting any recent acquisition programs, MANPRINT concerns were a factor in the termination of the Remotely Piloted Vehicle (Aquilla) program following Test and Evaluation Review.

program and DoD's HSI requirements. Finally, the study notes the need to develop analytic tools to identify and quantify the risks and costs associated with potential systems. The U.S. Army possesses an extensive catalogue of U.S. Army research tools to include HARDMAN III MPT analysis, JACK vehicle accommodation analysis, CREWCUT combat vehicle workload analysis, Vision Path analysis, anthropometric analysis, Partitioning analyses, and Control and Display analysis.

5. Program Success

Since its establishment, the MANPRINT program has been credited for a myriad of performance and life-cycle improvements to new, Non-developmental Items (NDI), and fielded systems. Without this evidence of improved system performance and/or cost savings, sustainment of the MANPRINT process would have been difficult. Amidst organizational downsizing, it is doubtful MANPRINT could have survived without a demonstrated pay-off. (Blackwood, 1994, p. 19)

From the outset, the MANPRINT program showed results. The Howitzer Improvement Program (HIP) was the first product improvement program as well as major weapons system to specify MANPRINT analyses as part of the contractor specifications. The results indicated the program's potential benefits and savings to the Army and its soldiers. The HIP program's MANPRINT achievements included the following:

- Reduction in crew size from five soldiers to four;
- Decreased predicted mean-time-to-repair (MTTR) from 4.1 hours to 1 hour;
- Redefined loader assist maintenance concept of isolating the electric, hydraulic, and mechanical system which reduced the lowest replaceable unit weight;

- Development of a system operable by all mental categories;
- Reduction of life-cycle costs savings by more than $6 million.

The MANPRINT's capstone success was the development of the T800 engine for the RAH-66 Comanche Helicopter program. Developed by Light Helicopter Turbine Engine Company (LHTEC), the T800 engine was the first major system to apply the MANPRINT from the beginning. The Army asserts that "by adhering to the MANPRINT principles, LHTEC effectively identified, improved (maximized), and integrated critical aspects of the human-machine relationship into the T800 engine design, and did this with the constraints of cost, schedule, and available technology." (DeGarmo, 1993, p. 19) Notable achievements included the following:

1. Reduction of manpower through the elimination of labor intensive tasks by:

   (a) the development of innovative design which reduced the number and complexity of engine parts;

   (b) using modular components;

   (c) increasing system reliability;

   (d) improving diagnostic, repair, and replacement capabilities.

2. Increased technical performance without increased requirements for maintainer mental capabilities;

3. Reduction of the number of user-level tools from 134 to six common hand tools.

According to one civilian manager, "MANPRINT forced use to look more closely at the needs of the soldier in the year 2000." To demonstrate the engine's capacity to be maintained by the future generation of Army soldiers, the contractor

"jury-tested" a mockup engine with a high school industrial arts class. After three hours of general training, the students successfully performed typical maintenance tasks within time limit specifications.

Another program lauded for its effective implementation of MANPRINT principles was the Pedestal-Mounted Stinger (PMS). Employing analysis of system design and testing data, corrections were incorporated to the detection, identification, tracking and firing sequences. Consequently, the probability of a successful launch and hit was improved from 0.816 to 0.918. The MANPRINT process was credited with producing a 10 percent increase in battlefield performance. To obtain the same increase in effectiveness using "uncorrected" systems was estimated to have cost $60 million in additional hardware and crews.

The final demonstration of MANPRINT's success was its acceptance by the international defense community. Based on the finding of its 1989 study, the British Army formally adopted the MANPRINT program. Subsequently, the program was expanded to encompass the whole British Ministry of Defense.

The French and German Ministries of Defense likewise shared a concern for the effects of failure to integrate human factors considerations into the procurement process. Both nations have directed the implementation of programs similar to MANPRINT. Additionally, NATO Defense Research Group Panel 8, which considers the defense applications of human and bio-medical sciences, has established a Research Study Group on Manpower, Personnel, Training, and Safety Integration. Combined, these efforts illustrate the growing awareness of the importance of human factors integration throughout the NATO Alliance.

E. SUMMARY

With increasing reliance on technology as a force multiplier, the Army recognized a growing disparity between its soldiers and the equipment they were expected to operate and maintain. Hence, the MANPRINT program was initiated to optimize total system performance through the consideration of soldier capabilities and limitations during the acquisition process.

From its inception, the MANPRINT program received the patronage of the Army's senior leaders. Strengthened and protected by this support, the MANPRINT program, unlike its sister Service counterparts, was able to successfully institutionalize the systematic integration of human issues into the acquisition process. Centrally managed by the MANPRINT Directorate and supported by an extensive organizational infrastructure, the program standardized the Army's HSI procedures while ensuring proper application through the establishment of formal incentives, training, and oversight.

By regulation, Program Managers are required to employ MANPRINT procedures. Their efforts are then evaluated by the MANPRINT assessment and review process, and reflected in their performance reports. Integration is achieved through the Joint MANPRINT Working Group, and subsequently documented in the System MANPRINT Management Plan. Through the MJWG a forum is established to provide visibility and continuity to human issues. If not adequately addressed, critical issues can ascend through the MANPRINT hierarchy to the ASARC for final resolution.

The ultimate testimony to MANPRINT's organizational success was the incorporation of its fundamental principles into DoD's HSI policies. However, to definitively measure MANPRINT's effectiveness at human systems integration, its policies and procedures must be evaluated at the acquisition

program level. Hence, Chapter VI will analyze the application of MANPRINT within the AGS and AAWS-M programs. From this evaluation, generalizations will be drawn for comparison to the Marine Corps' current HSI program.

V. MARINE CORPS HUMAN SYSTEMS INTEGRATION CASE ANALYSES

A. INTRODUCTION

The Marine Corps acquisition process is founded on two underlying tenets: first, that each acquisition program is unique and should be managed accordingly, and second, that the Program Manager, who is ultimately responsible for the system, should have minimal restrictions placed on his authority. The impact of these philosophies reverberate throughout the Marine Corps HSI program. The HSI Attributes Matrix contained in Appendix A provides the raw data utilized to quantify these effects. A synopsis of the results is presented in Table 5-1.

HSI ATTRIBUTES	AAAV		SRAW	
	Score	Percent.	Score	Percent.
A. Organizational Policy	27	11.3	24	10.3
B. Organizational Oversight	25	10.0	20	8.0
C. Organizational Support	17	8.5	15	7.6
D. Program Application	86	25.5	62	18.2
TOTAL PROGRAM EFFECTIVENESS	**155**	**55.3**	**121**	**44.1**

Table 5-1 Total Marine Corps HSIAM effectiveness values by HSI attribute category.

This chapter analyzes the effectiveness scores assigned to the AAAV and Predator programs. First, the methodology employed in assigning qualitative effectiveness scores in the HSIAM is reviewed. Secondly, after reviewing the current status of both programs, the chapter amplifies the information and insights used in the assignment of individual response scores. Employing the HSIAM scores as a gauge, the chapter evaluates the manner and degree to which HSI is performed within Marine Corps major and non-major acquisition programs.

Finally, conclusions are drawn from the HSIAM's aggregate mean scores as to the overall effectiveness of the HSI program for later comparison with the Army MANPRINT program.

B. QUALITATIVE EVALUATION METHODOLOGY

The HSI Attributes Matrix was designed to measure the extent to which the Army and Marine Corps have established HSI programs to execute the requirements set forth in DoD Instruction 5000.2, Part 7, Section B, and enumerated in Chapter II. The matrix was developed after reviewing the current body of knowledge on human systems integration within the Department of Defense. First, to derive relevant dimensions of measurement, the factors critical to the effective implementation of HSI were identified by investigating comparable previous efforts, as described in Chapters II, III, and IV. Four key factors were identified: 1) organizational[14] policy; 2) organizational oversight; 3) organizational support, and 4) Program Management knowledge and application of HSI principles and procedures. Secondly, within the framework of these four broad categories, specific questions were constructed to measure the degree to which each function was performed.

Questions were arbitrarily weighted by the researcher based on the extent to which they impacted implementation of DoD's policies regarding human systems integration. Weights ranged from two to six percent of the total score. Individual item scores and percentages then were tallied to produce category totals, and ultimately an overall HSI effectiveness grade for each program in the two Services. The qualitative evaluation scale used for scoring is addressed in the next

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[14] To standardize the matrix questionnaire while accounting for Service-unique institutional structures, the term "organizational" is used here to refer to the actions of the Service and/or its Acquisition Command(s).

section. Sensitivity analysis was performed on both the category and individual response values to ensure that no single factor unduly influenced the outcome of the analysis.

Responses to the matrix questions were derived from interviews with program management personnel, and/or examination of program, Service, and DoD documentation pertaining to the individual program's HSI policies and procedures. Subsequently, the USAF "Qualitative Evaluation Model" was used to assign numerical values to the appropriate qualitative factors. The model assigns score values from zero to ten based on the performance of the test sample in comparison to an established standard. Table 5-1 exhibits the score values and their corresponding interpretations.

Score	Description
10	Perfect
9	Outstanding
8	Well above standard
7	Above standard
6	Slightly above the standard
5	Same as standard
4	Slightly below standard
3	Below standard
2	Well below the standard
1	Unacceptable
0	Of no value

Standard: 1. Comparable to the average of similar items.
2. Comparable to the item being replaced by the item under test.

Table 5-1 Air Force qualitative evaluation model. (Simon, 1974, p. 12)

The standard for evaluation was based on the consolidation of two baselines: 1) the HSI requirements found in DoD Instruction 5000.2, and 2) the average of similar Armed

Forces HSI programs. This evaluation further recognized and accounted for the effects of program tailoring of HSI efforts based on ACAT designation. Each program was judged against the standard HSI effort applied to programs of a similar nature and magnitude.

C. PROGRAM OVERVIEWS

1. The Advanced Amphibious Assault Vehicle Program

The Advanced Amphibious Assault Program is the Marine Corps' only current ACAT I D acquisition. Its objective is to obtain the most cost-effective, operationally suitable, and affordable system which can lift the surface assault elements of a Marine Expeditionary Force from amphibious ships located over-the-horizon (OTH) to inland objectives. In accordance with the Navy/Marine Corps "Forward... From the Sea" doctrine, the system must provide forcible entry capability and serve as the principal means of tactical surface mobility for the Landing Force during subsequent combat operations ashore. (DRPM, AAA, p. 3, 1994)

The AAAV is to replace the current family of Assault Amphibious Vehicles (AAV7A1) with state-of-the-art technology that will fulfill the mission need of the Marine Corps during the FY 2000 to FY 2020 time frame. Incorporating advanced composite armor and new weapons, the AAAV is expected to defeat future threat light-armor vehicles frontally at ranges of at least 1500 meters while on the move and under conditions of darkness and adverse weather. In addition, the AAAV will include a powerful propulsion system designed to dramatically increase the vehicle's speed on land and at sea. The AAAV is required to be operated and maintained by a crew of three Marines, and possess the lift and carrying capacity for 18 combat-loaded Marines.

Originally scheduled to begin development in 1992, the AAAV program was delayed while Marine and Navy officials

sought to reduce the degree of technical risk associated with the program and to determine its funding. Schedules now call for a four-year demonstration program, with a single prototype being produced by 1998. The Marine Corps plans to purchase 1,013 AAAVs with initial operational capability planned for 2005 and full operational capability by 2011. Table 5-2 displays the projected total life-cycle cost of the AAAV program by phase in millions of Base Year 1993 dollars. General Dynamics Lands Systems Division of Sterling Heights, MI, and United Defense, Limited Partnership of Santa Clara, CA, are each presently working under $15 million contracts to test engine technology concepts.

The AAAV program possesses a unique organizational structure. The Program Manager holds direct reporting authority to Assistant Secretary of the Navy, Research, Development, and Acquisitions (ASN,RD&A). Simultaneously, he maintains a Memorandum of Agreement (MOA) with MARCORSYSCOM for the provision of formalized contracting, budgeting, and

Phase	Cost (BY93$M)	Phase Duration (from contract award)
D&V	272	49 months
E&MD (less LRIP)	407	69 months
LRIP	562	48 months
Production	3,578	78 months
*O&S	4,198	20 years
Disposal	12	48 months
TOTAL	$9,029	44 years

*Includes $2,286 for existing USMC personnel

Table 5-2 AAAV acquisition program life-cycle cost estimation.

legal support. The use of other MARCORSYSCOM agencies is at the discretion of the Program Management Office (PMO). Other interaction and information transfer with MARCORSYSCOM is on an informal basis only.

In November 1994, the AAAV program was reviewed by the Joint Requirements Council and approved as a valid military requirement. The program is currently scheduled for Milestone I MCPDM review in January 1995 and subsequent Defense Acquisition Board (DAB) review in April 1995.

2. The Short-Range Anti-tank Weapon Program

The Predator, Short Range Anti-tank Weapon, is a lightweight, anti-armor rocket developed to replace the AT-4 Rocket and the Shoulder-Launched Multipurpose Assault Weapon (SMAW). The system is designed to provide dismounted infantry units with the capability to destroy next generation advanced armor threats. The man-portable, 18 pound Predator incorporates "fire and forget" technology, a soft-launch capability, and a top attack (fly-over, shoot-down) profile.

The Predator Program is currently a unilateral Marine Corps ACAT III procurement, although a joint Memorandum of Agreement exists with the Army to share technology and program support. The Program Manager anticipates that due to Army interest the program will rise to ACAT II designation during production.

In December 1990, upon completion of a six-month concept exploration phase, the system's operational requirement was validated and the program entered a 30-month demonstration and validation phase. Following the successful completion of flight tests verifying prototype designs and the fabrication of critical components, the Predator Program entered the engineering and manufacturing development (EMD) phase in June 1994. A contract was awarded to Loral Aeronutronic, commencing a 44-month EMD phase to be completed by January 1998. Procurement is scheduled to begin during 1999 at a cost

of $4,000 per unit. Program costs include $120 million for research and development and $200 million for procurement appropriations.

D. ORGANIZATIONAL POLICY

Within HSIAM Category A, the AAAV and the Predator programs averaged slightly-above standard (5.6) and standard (5.1) scores respectively, for organizational commitment to HSI as indicated by their Service's and/or Acquisition Command's policies, procedures, and incentives. Reaffirming the fundamental tenets of the Marine Corps acquisition community, both programs however scored strongly (8 and 9) with respect to the empowerment of Program Managers to efficiently manage their programs.

1. Proponency and Policy

The matrix scores for this category and the historical review conducted in Chapter III both demonstrate that human systems integration has received little formal support from senior Marine Corps acquisition officials. *While acknowledging HSI as a DoD requirement, no senior Marine leader has yet to champion the cause of HSI.* During the course of this research, efforts to discuss HSI issues with senior military officials were continually redirected to subordinate staff members for resolution.

The lack of senior leadership commitment to HSI is evidenced by the limited guidance provided to acquisition practitioners. Not until August 1994, one-and-a-half years after the publication of SECNAVINST 5000.2A and over three years after the issuance of DoD 5000.2, did MARCORSYSCOM issue its guidance on the implementation of DoD's HSI policies. MCO 5000.22, "Implementation of Defense Acquisition Management Policies, Procedures, Documentation, and Reports," contributed only marginally to defining the roles, and responsibilities required for the performance of HSI. Through a Points-of-

Contact (POC) chart, MCO 5000.22 assigned responsibility for HSI execution to the PM and responsibility for support to the Program Support Directorate, the Training Systems Program Management Office, and the Marine Corps Tactical Systems Support Activity (MCTSSA).

In the absence of senior-level guidance, subordinate command organizations were also found to lack formal policies clarifying HSI execution. No PMO or support organization interviewed could produce documentation outlining its standard HSI procedures. As a consequence, the command is compelled to rely extensively on its civilian work-force to provide continuity and consistency to the performance of HSI.

The conflicts inherent in this approach were self-evident prior to the publication of MCO 5000.22 when Program Managers, Project Officers, and Logistical Engineering Managers (LEM) each interpreted and applied the dictates of DoD Instruction 5000.2 differently. One staff member explained the situation from a LEM's perspective. First, he said, "there is no unit-level SOP or desk-top procedures, and it is unlikely that a LEM would have a face-to-face turnover." Lacking guidance, the LEMs consequently interpret their responsibilities based on personal experience, understanding of the HSI process, and a review of available directives. "It is basically a seats-of-the-pants operation," he asserted. Yet, he continued, almost immediately upon entering the command LEMs are required to make support decisions based on their billets. "As Marine Officers," he said, "we will make the decisions, but we don't have to live with those decisions because it is probably three, four or five years before the effects are felt." This situation is expanded upon in a later discussion of the failure of non-major programs to develop HSIPs.

Compounding this situation and providing further resistance to the development of systematic HSI procedures is the acquisition community's inherent belief that each program

is unique and should be managed accordingly. HSI roles, responsibilities, and procedures are developed individually for each program. As a result, greater variability is introduced into the application of HSI among Marine Corps programs, according to such factors as the PM's knowledge and experience, and the support agencies' competence and consistency. The issue of diversity is addressed in subsequent sections.

Also absent from the Marine Corps' procurement process are formal incentives to promote HSI. The COMMARCORSYSCOM is not formally directed to consider the PM's execution of HSI responsibilities during performance appraisals. While no policy delineates exact evaluation criteria, PMs are generally not judged on their system's capabilities, performance, or life-cycle costs. Instead, due to the PMs' short tenure and the consequences of prior program decisions, fitness reports normally consider only the PM's overall job performance and competence as a Marine Corps officer.

MARCORSYSCOM imposes no other requirements on its PMs to perform HSI beyond those outlined in DoD Instruction 5000.2. By policy, PMs are under no obligation to seek or accept the counsel of MARCORSYSCOM HSI practitioners. In an internal customer satisfaction survey in 1991, PMs were asked to rate their interaction with Program Support. On a scale from 0 being minimum interaction to 5 being maximum interaction, the average of all respondents was 1.9. Several survey responses displayed the frustration of support personnel at the absence of incentives. One protested that "PM's ignore Program Support and other requirements and get away with it!" Another recommended more vigorous application of Logistics Appraisals. "This will at least cause PMs to halfway consider LEM recommendations." No current data is available regarding how many PMs utilized MARCORSYSCOM's HSI resources, to what extent, or to what effect. According to one practitioner, the

only incentive for PMs to effectively execute HSI is "their desire to do the job right."

2. Program Manager Autonomy

What the Marine Corps HSI process lacks in bureaucratic guidance, systematic procedures, and institutionalized incentives, it offsets by empowerment of its Program Managers. Ultimately responsible and intimately knowledgeable, PMs are given wide latitude in the management of their programs. This authority is further relegated to POs in the management of their projects. Besides legal and fiscal constraints, only two checks were identified which restrict the PM's authority: 1) ORD thresholds, and 2) the Milestone Decision Review process. The effectiveness of these media in reigning the PM's actions will be examined in the next section.

The goal of this laissez faire command philosophy appears to be to optimize the program efficiency and effectiveness. However, one acquisition practitioner contends that the lack of institutional restrictions is sustained by the "Golden Rule." "He who has the gold rules, and the PMs have the power of funding," he observed. Notwithstanding, Marine Corps PMs enjoy a broad degree of autonomy in the execution of their duties to include the performance of HSI.

E. ORGANIZATIONAL OVERSIGHT

In the category of organizational oversight, the Marine Corps was graded as slightly-below standard (4.5). The AAAV Program earned an average score of standard (5), while the Predator Program obtained an average score of slightly-below standard (4). The cause was twofold: 1) the narrow involvement of the user/maintainer proponent in the acquisition process precipitated by current HSI procedures and organizational relationships, and 2) the limited visibility afforded into the HSI decision-making process by current documentation procedures.

1. User Proponent Visibility

The qualitative evaluation scores demonstrate that the proponent for the end-user has limited involvement and thus, oversight of the system design and development process. By Marine Corps Order, MCCDC is designated the proponent for the system operator in the material acquisition cycle. Through operational thresholds documented in the ORD, the MCCDC Requirements Division provides guidelines to the PM for system development. During the acquisition process, the designated Requirements Officer is advised of the program's status during Milestone Reviews. A member of the AAAV Program Office illustrated this narrow window of visibility when he said:

> At Dem/Val we will have to closely coordinate with MCCDC to say 'We are the Combat Developers for you, we only have this much money and this much technology. You have to make the trade-offs. How is the Marine Corps going to off-set the ability to do this or that?'

Since MCCDC is the only agency authorized to modify the ORD or approve waivers, it is also incumbent upon PMs to inform MCCDC when an ORD threshold will be breached. Beyond this, PMs have no formal requirement to apprise Requirements Officers of HSI decisions or trade-offs made during system design and development. The degree to which MCCDC is informed of system design decisions is left to the discretion of each PM.

The question of who ultimately represents the needs of the system operator was a point of contention among many of those interviewed. One Project Officer went as far as stating:

> Within the Marine Corps there is no proponent of the field Marine as there is in the Army with the schools. They [TRADOC] speak for the soldier. It there are proponents in the Marine Corps, the don't stand up and make it known.

Other acquisition practitioners acknowledged that although by doctrine Requirements Division owned the responsibility, the function is actually being performed by other organizations, specifically the Program Support Directorate or the Program Management Offices. One practitioner stated:

> No one else is that interested. The Requirements personnel lay out the requirements, but once the requirements are defined, unless you go to them with a problem, they have other things to worry about -- more requirements to write. It is up to us [Program Support] to keep it [HSI] in our mind, and get out there and talk to the Marines who will be using the equipment.

Conversely, a PMO staff member argued that it is the PM who is the ultimate proponent for the Marine in the acquisition loop. He stated:

> We have such a wide base of experience in this organization [Program Management Office] in rank and knowledge... If we see something wrong we go out and try to fix it. It's not required, and we get chewed out a lot about taking on responsibility because other people won't do it.

This controversy over who represents the needs of the Marines in the acquisition cycle is, in and of itself, testimony to the inadequate involvement of the operator proponent.

Not actively informed or involved in the HSI decision-making process, MCCDC Requirements Officers are thus unable to effectively influence system design. Because visibility is afforded to the user proponent only at Milestone Reviews or when requirement thresholds are to be breached, it is the ORD which ultimately defends the needs of the system operators and maintainers. Therefore, the capability of the system to address human issues is based on the integration of HSI requirements into the ORD. Yet, as detailed in Chapter III,

the ORD is staffed, rather than integrated, between the HSI disciplines, and thus HSI parameters and/or trade-offs may or may not be adequately identified.

2. HSI Audit Trail

The absence of a traceable audit trail further precludes visibility into the HSI decision-making process. MARCORSYSCOM does not require the documentation or tracking of HSI trade-offs. No formal audit trail is typically maintained unless requirement thresholds are expected to be breached. Otherwise major trade-offs are documented at the discretion of the PM. Often times decisions are documented only to safeguard against later external challenges or accusations.

Neither the AAAV nor the Predator programs currently maintain a system to audit HSI issues. The AAAV PMO however requires that competing contractors supply data deliverables which identify, weigh, and rationalize the HSI trade-offs made during systems design. Internally, the AAAV Program relies on In-Process-Review (IPR) notes to track HSI issues brought forward for debate. The Program's MPT Specialist confirmed that "there is not always a clear audit trail," other than the performance of trace studies, such as JACK and CREW-CUT prototyping, to resolve identified deficiencies.

A critical report by the DoD Inspector General's Office in June 1993 best illustrates the failure of the ORD to adequately address human issues and the inability of the audit trail to substantiate Marine Corps contentions. Following an extensive pre-Milestone I audit, the IG's Office published Audit Report 93-116, "Acquisition of Advanced Amphibious Assault Vehicles." The report cited studies by the U.S. Army Research Institute of Environmental Medicine in 1981 and the U.S. Army Natick Research and Development Center in 1986. Both studies supported the need for a cooling system to prevent performance degradation of troops wearing Mission Oriented Protective Posture (MOPP) clothing while embarked

aboard armored vehicles in extreme climatic conditions. The report contends that MCCDC was aware of the need for an environmental control system in the Amphibious Assault Vehicle, but had failed to include a performance characteristic to satisfy the deficiency in either the AAAV draft ORD or Required Operational Capability (ROC).

The audit report concluded that the oversight would require the design of the vehicle chosen for the AAAV Program to be modified to incorporate an environmental control system so that Marines could effectively use the vehicle in hot, NBC conditions. The Belvoir Research, Development and Engineering Center estimated the inclusion of such a system to individually cool the troops would increase the cost per vehicle by $20,000 to $40,000. If the entire troop compartment were cooled, the Army Institute estimated that the costs per vehicle could increase by as much as $250,000. (Inspector General, 1993, p. 21)

Although the ASN(RD&A) concurred with the report, the AAAV PMO contends that the requirement for a cooling system was included. However, instead of specifically requiring the contractors to provide an air-conditioning unit, the program office stated the requirement in operational terms. According to a program staff member:

> We gave the temperature range and the mission, and said this is how the Marine needs to operate without any degradation of his performance. You [the Contractor] come up with the material solution.

Finally, lacking a detailed audit trail, the Program Office had to gather IPR notes and internal facsimile messages to prove that heat considerations were included in HSI discussion.

3. HSI Review and Assessment Process

Subject to both DoD oversight and voluntary MARCORSYSCOM review, the AAAV Program obtained a slightly-above standard score (6) for the effectiveness of its HSI assessment procedures. With only MARCORSYSCOM review, the Predator Program was rated as standard (5). For both programs, though, institutional oversight is confined to Milestone Reviews. A support staff member outlined the risks inherent in this approach:

> If the PM has not done it [HSI] so well, you correct the problem as best as you can. Sometimes, though, you are in a position where it is too late to correct the problem before it is fielded. If you determine not to buy the system or delay the procurement, your money is then at risk.

He equates the current program review process with traditional quality control techniques wherein inspections are conducted at the end of a production line instead of during the production cycle. He concludes that the "corporation," (MARCORSYSCOM) is assuming that the production-line (the Program Manager) has analyzed the incoming data correctly.

As discussed in Chapter III the sole evaluation of HSI disciplines currently occurs during Logistics Appraisals, the results of which are forwarded to PA&E for inclusion during Milestone Review. The Program Support Directorate, which holds cognizance over the logistical certification process, acknowledges the difficulty in reviewing and rationally assessing program documentation and decisions if not formerly involved in the development process. If the reviewing official does not know the previous trade-off decisions made by the PM "it is very easy to ask questions that are superficial or perfunctory, questions that do not make any sense because we don't know the background," observed an HSI practitioner. If not actively involved, the PS Directorate can only review the documentation for form and content without

assessing the rationale behind the decision-making process.

The correction of HSI issues was found to be enforceable within MARCORSYSCOM's review procedures. At least six-months prior to Milestone Review the findings of the LAR or LRG are submitted to the appropriate PM for response. In turn, the PM submits the actions he anticipates to be necessary to correct the problem. Major findings are subsequently tracked to ensure that the corrective actions are taken.

4. Feedback Mechanisms

The Marine Corps was found to possess an informal, yet effective feedback mechanism for the evaluation of human issues during the acquisition cycle. Both programs earned praise from external sources for their extensive and effective use of user-juries early in the procurement process. An HSI consultant to United Defense, Limited Partnership, observed that the Marine Corps traditionally provides experienced users who are knowledgeable of the predecessor systems and dedicated to the trial process.

To aid in this effort the Predator Program was only one of four programs to employ the services of a Marine Corps MANPRINT Specialist. The Specialist was used primarily to assemble, organize, and supervise Marines in the performance of hands-on evaluations (user-juries) of system prototypes. Marines assigned to The School of Infantry and The Basic School's Instructor Company were provided opportunities to handle the Predator prototype and provide comments to improve design. Following system tracking tests performed at Dahlgren, VA, the Marines provided several constructive recommendations:

1. Redesign the eye-plate to be adjustable to accommodate better eye placement during gas-mask firing.

2. Redesign hand-grip placement for ease of firing.

3. Reduce protective padding to minimize system bulk.

In addition, the MANPRINT Specialist stressed the need for design testing to accommodate "Marine-specific" tasks, such as shipboard transportability and salt-water immersion. "We use the MANPRINT Specialist for a sanity check," said one staff member. Despite his efforts, no documentation could be found recording the MANPRINT Specialists HSI recommendations nor tracking their inclusion in the Predator's design process.

One acquisition practitioner defended the Marine Corps' informal feedback mechanism by illustrating its use in the development of pump-jets for outboard motors. Two former Reconnaissance Marines approached the Ground Weapons PM complaining about injuries incurred by standard outboard motor blades. The PM then initiated design efforts to resolve the problem, which resulted in the development of shielded pump-jets.

Despite the apparent willingness of PMs to accommodate the expressed needs of systems operators, systematic procedures could not be found for identifying safety trends from the Fleet Marine Force. Had the Reconnaissance Marines not voiced their concerns to the PM, it is unlikely that the current safety analysis procedures would have detected or communicated the problem. This deficiency is further illustrated in the next section dealing with organizational support.

F. ORGANIZATIONAL SUPPORT

Category C of the HSIAM demonstrates that the Marine Corps has yet to develop a strong functional support organization to control or supervise HSI within the acquisition process. Overall, the Marine Corps was rated as slightly-below standard (4), by virtue of both the AAAV and Predator programs earning slightly-below standard scores (4.2 and 3.8 respectively). Additionally, the evaluative scores reflect the autonomy granted to Program Managers in the

determination of how and when HSI will be addressed during the procurement process. Finally, the scores demonstrate that although the PMs are tasked with HSI performance, they and their staffs are afforded limited training commensurate with those duties.

1. HSI Support Resources

The Marine Corps acquisition community does not possess the requisite resources necessary to support HSI for major programs. Several AAAV staff members confirmed the lack of HSI expertise required for ACAT I and II programs. They credited this to the fact that the predominance of MARCORSYSCOM's procurement efforts are directed toward ACAT III and IV programs. Expressing a common sentiment, one practitioner asserted that non-major programs do not require the same degree of HSI expertise.

Unable to be adequately supported, the AAAV program was compelled to rely on external HSI sources. Seeking to obtain the best support available, the program enlisted the services of the Naval Air Warfare Center (NAWCTSD), Orlando FL, originally the Naval Training Systems Center, and the U.S. Army Human Resources and Engineering Directorate, ARL.

As a non-major system, the Predator program was able to effectively employ the services of the System Command's Program Support Directorate. While the Predator program has maintained good relations and received adequate support from PS, interviews with other staff personnel revealed persistent problems with the HSI support structure.

To better serve their constituency, the Program Support Directorate between 1991 and 1992 conducted three major surveys of customer satisfaction within the PMOs. While each survey exhibited support improvement, the final survey identified the following five areas of concern, listed in descending order of priority:

- Timeliness of Support;

- Staff Program Knowledge;
- Personnel Continuity;
- Proactive Involvement;
- Communications.

Criticisms leveled at PS in the 1991 survey responses included the following:

- "As a matrix organization, PS very easily dons the mantle of overwork and does not provide support in a timely fashion."
- "To be effective, PS personnel must become more involved with the PMs' programs; just sitting at their desks reviewing documents for programs which are completely unfamiliar to them is a non-workable situation."
- "Very little attempt on PS's part to keep abreast of programs and monitor status."
- "The support provided by the LEMs needs to be more of a 'team' effort. Many times I feel that there is a 'we-them' relationship."

Such criticisms still echo through some program offices. One program staff member challenged the allegiance of PS personnel to individual programs. Another PO complained that the recent reorganization of the MPT functions into the Training Systems Program Office had severed the PMs' direct link to the LEMs. He explained, "The support we have received since the LEMs merged into PM, Training Systems, has been reduced quite an extent. Their allegiance is now with PM, Training Systems, and not our program."

A second criticism which persists is that Program Support lacks consistency in the assignment of personnel to assist programs. Program staff members cited that frequently the support personnel designated to attend working groups is not the same person who subsequently reviews program documents

when staffed for comment. As one practitioner noted in the 1991 survey, "Placing a warm body to fulfill a requirement slows, if not inhibits, a productive meeting/review." For this reason, many PMs turn to civilian contractors for support consistency and more timely products.

The Program Support Directorate is cognizant of the charges levied against it. The Director acknowledges the inefficiencies inherent in any matrix support system, such as staffing limitations and performance time. However, he also recognizes the organization's contradictory role both of supporting PMs while protecting the best interests of the Marine Corps. Due to this, he theorizes, some PMs are reluctant to use PS. Because they may not receive the answers they want, the PMs turn to contractors for support.

To better support the needs of the Program Management Offices, a major reorganization effort is presently underway within the PS Directorate. The initiative will include the consolidation of all program Logistics Mangers under the direction of PS by April 1995. The PS Director predicts that within one year this action will improve the consideration of HSI issues while relieving PMs of burdensome logistical responsibilities.

One senior HSI practitioner supports continued realignment of the command after the Naval Air Systems Command model. Under that system, PMs manage only programmatic issues such as acquisition strategies, planning, documentation, whereas the "ilities," such as MPT, training systems, and weapons systems engineering, are handled through a common support agency. In summarizing NAVAIR's procedures, he stated that the "ilities" to include HSI are then handled by "the corporation, not by the product line." The result is increased process consistency. In this way, proponency for the end-user is maintained within the corporate support structure. Even when support responsibilities are contracted

to commercial enterprises, the results are still channeled back through a common support organization.

2. HSI Forums

The forums utilized to address HSI issues varied greatly between the AAAV and Predator programs. The AAAV Program used the open forums provided by the In-Process-Reviews to voice and resolve HSI trade-offs. Periodically scheduled throughout the acquisition cycle, IPRs address each subsystem of the program, thereby allowing each HSI discipline an opportunity to express concerns. The AAAV program is unique in that it requires economic analysis to be presented concurrently with the discussion of HSI alternatives.

Like other non-major programs, the Predator Program possesses no forum to specifically address HSI issues. Instead, the PM plans to handle all "ilities," including issues related to the six HSI disciplines, within the ILSMT. This action further subordinates human issues to logistical issues. The PM expects the Test Integration Working Group (TIWG) to also address some HSI-related issues. The TIWG, which has yet to be organized, is intended to prepare the system for operational testing and subsequently for deployment training. The Predator Program's lack of an integrated forum to examine human concerns is displayed in its below-standard matrix score.

3. HSI Education

Within the Marine Corps acquisition community, HSI education is limited. The only educational requirement currently placed on program staff or support personnel is attendance at an introductory Project Officers Course. The five-day orientation course presents a cursory overview to MARCORSYSCOM acquisition procedures and organizations. The HSI disciplines are briefly reviewed during a tour of the Program Support Directorate.

Human Systems Integration is also presented in the

Defense Systems Management College (DSMC) Program Managers Course curriculum. During the course, DoD Instruction 5000.2 HSI requirements and current HSI procedures are reviewed. The AAAV DRPM and Logistics Manager, as well as the Predator PM have all attained DSMC Level I certification. The Marine Corps's access to the course has been restricted by DSMC's policy to grant attendance priority to major program personnel. At the request of the MARCORSYSCOM Commander, this policy is presently being reexamined. To compensate, one HSI practitioner, acknowledging the need for enhanced HSI training, recommended that all future PMs send at least one staff member to the Army's MANPRINT management course.

G. PROGRAM APPLICATION

1. Overview

Category D, Program Application, examined how effectively HSI was understood, supported, and executed within each individual Program Management Office. This category exhibited the largest variance of qualitative evaluation scores within the HSIAM. The Marine Corps earned superior scores for its Program Managers' commitment to satisfying the needs of the system operator with the AAAV and Predator programs received outstanding (9) and well-above-standard (8) scores. Reflecting the factors which influenced its development, the Marine Corps HSI program received consistently strong scores (6.5, 6.5, and 7) for documentation of MPT issues, while simultaneously applying descending emphasis on human factors engineering (5), system safety (4), and health hazards (4).

2. Program Management Commitment

The strength of the Marine Corps HSI program is found in the commitment of its Program Managers to satisfying the needs of system operators and maintainers. Within the acquisition community there exists an organizational culture which emphasizes the consideration of the Marine end-user during

system development. While not mandated by policy, this determination to develop user-friendly systems within the limits of fiscal constraints was evident during interviews with program personnel.

According to one acquisition practitioner, MARCORSYSCOM is more operator-oriented than any other system command organization. He credits this condition to the high ratio of military to civilian personnel in the acquisition work-force. Military personnel which comprise 60 percent of the work-force, he asserts, understand the need to "Marine-proof" equipment because of their occupational backgrounds, and therefore demonstrate an inherent concern for human factors issues. He observed that "because the PMs and POs may have to used the gear, it is important to them that it [HSI] is done right." Current Marine Corps policy allows military acquisition work-force personnel to alternate between operational and acquisition billets on subsequent tours of duty. Acquisition practitioners retain their primary MOS and remain affiliated with that field throughout their careers.

A MANPRINT practitioner comparing Marine and Army practices echoed this opinion. He observed that, in general, Marine Corps PMs possess greater operational awareness and provide greater user expertise to the design and development process. This operational knowledge and demand for operational performance, he said, is relayed to contractors during routine interactions. This conviction was reaffirmed by a civilian HSI consultant to United Defense, L.P.

Within the AAAV Program, HSI reaps the benefits of the DRPM's strong advocacy of logistical considerations. According to one staff member, the Program Manager places tremendous emphasis on logistics, under which HSI is addressed. The Predator Program Manager also displayed ardent commitment to the consideration of the Marine end-user. His statement acknowledging the difficulty in translating the

user's requirements to the system design engineers evidenced his concern:

> The initial design concept came from engineering putting the design together in a logical sequence, but that may not always be best for the Marine. To the engineer who designed it, arm placement is not that important, but to the Marine who has to hump or use it to save his life a few inches can make a big difference.

Powered by the strength of the PM's commitment, the Marine Corps HSI program is consequently personality dependent. The application of HSI is driven by the PM's knowledge, commitment, and experience. Because of PM autonomy and procedural decentralization within MARCORSYSCOM, the emphasis placed on HSI is proportional to how attuned the PM is to the nuances of the acquisition process. Illustrating this fact, an AAAV Program staff member conceded that the PMO is growing "increasingly suave" of HSI considerations as the program progresses.

The effect of this situation is greater variance in the degree and effectiveness of the HSI execution. A Program Support member summarized the situation by stating:

> We [MARCORSYSCOM] have a diffusive effort. We have seven PMs and 75 Project Officers all going out at different points on the compass. If plotted on a statistical control chart, we would be all over the page.

Because the process lacks consistency, confidence in the PM's or PO's performance also becomes personality dependent. Unable to be intimately involved or informed on each of the programs, the PEO is therefore compelled to make decisions based solely on the PM's performance record.

3. HSI Comprehension

While committed to the needs of the systems operators and maintainers, the PMOs did not display a correspondingly strong understanding of HSI principles. As a major program supported by a multi-Service staff, the AAAV program demonstrated a sound understanding of HSI concepts. Both the NAWCTSD and HRED representatives brought to the program extensive knowledge of HSI based on previous operational experience with the Army's MANPRINT process. The narrower appreciation of HSI exhibited within the Predator Program was more typical of the understanding demonstrated throughout MARCORSYSCOM.

Significant portions of the acquisition command did not appear to thoroughly understand the relationship between MPT and HSI. Numerous persons interviewed expressed the belief that the performance of a HARDMAN MPT model was equivalent to the performance of HSI. Others confused HARDMAN with MANPRINT. One LEM assigned to support HSI errantly stated that "a HARDMAN analysis is the Navy equivalent of the MANPRINT for the Army."

The evolution of this belief is clearly seen in the historical development of the current HSI program, as outlined in Chapter III. Although it was a fundamental building block in the construction of DoD's HSI requirements, HARDMAN, itself, never evolved into a comprehensive HSI program.

The history of the AAAV Program illustrates how this misconception has propagated and has subsequently resulted in the failure of Marine Corps programs to balance or integrate HSI disciplines. Since the AAAV Program originated prior to publication of the DoD "5000 Series," the PMO initially complied all of its human factors issues under the heading of a HARDMAN program. Internally, the program office defined HARDMAN to include not only MPT but also human factors engineering, safety, and health hazards. A staff member notes that "initially the program had a Data Item Description (DID)

that we called HARDMAN assessment, which was really our MANPRINT structure... we more or less used the term HARDMAN to camouflage that we were doing MANPRINT work." This action was taken because at the time the program was under NAVSEA direction, and the program staff deemed that it would be difficult to process a MANPRINT DID.

By continuing to equate HARDMAN with HSI, acquisition practitioners are neglecting to fully integrate all six HSI disciplines, as evidenced by the inadequacy of program documentation discussed in the next section. Interviews also showed that many of those who did understand the components of HSI, did not appreciate the requirement for integration. Several practitioners expressed the mistaken belief that the separate analysis of each discipline satisfied the intent of DoD's HSI policies.

4. HSI Support Structure

Neither the AAAV Program nor the Predator Program possess a staff member specifically assigned to the management of HSI. Within the Predator PMO, which consists of four personnel: the Program Manager (O-5); two Assistant-PMs (O-3), and a civilian ILS Manager (GS-13), the Program Manager retains control of HSI issues.

Lacking formal HSI training, the PM relies extensively on the support of the prime contractor, other independent contractors, the Program Support Directorate, and the Training Systems program office to perform HSI analyses. Additionally, the program employed the services of a MANPRINT Specialist, whose duties were restricted primarily to the organization and supervision of user-juries. Ultimately, the PM was responsible for the evaluation and integration of the HSI data provided by these agencies. His expertise for this task is derived from his knowledge of user needs gained from previous operational experience in the FMF.

In contrast, the AAAV Program boasts a more highly

evolved HSI support structure. Responsibility for HSI control and coordination is delegated to the Integrated Logistics Support (ILS) Manager. Untrained in HSI techniques, the ILS Manager, nonetheless, demonstrated functional knowledge of HSI-related issues gained from prior logistical experience.

As noted earlier, the AAAV Program was required to employ external sources to build an effective HSI management team. The Naval Air Warfare Center supplied the program with a MPT Specialist, an Instructional Systems Specialist, and two Economists for the performance of MPT and economic analysis. The U.S. Army's Human Resources Engineering Directorate, ARL. has assigned an Individual Systems Design Method Team Leader from the Integrations Methods Branch, MANPRINT Division to the program. Primarily tasked with system analysis modeling, he is responsible to NAWCTSD for human factors engineering.

The weakest link within the HSI support structure is system safety. System safety analysis is tasked to a member of the PMO. His responsibility is to coordinate safety issues with MARCORSYSCOM and Naval Air Warfare Center. Safety information is then compiled and forwarded to the ILS Manager for integration and management. The AAAV Program is only now in the process of developing an institutionalized safety team, to include the Naval explosive warfare experts from both the Naval Warfare Systems Center and MARCORSYSCOM.

In October 1993, the Naval Safety Center assumed responsibility for tracking Marine Corps ground system safety. Despite the fact that annually the Marine Corps sustains approximately $1,620,000 in injury costs and $515,000 in property damage due to operational accidents, effective communications between the Naval Safety Center and the Marine Corps acquisition community have yet to be established. To date the only interface the AAAV Program has had with the Center is through the receipt of monthly bulletins and tracked vehicle incident reports.

Also exhibited within the AAAV Program is the tendency of Marine Corps safety programs to focus exclusively on system safety, vice individual Marine safety. The same holds true for survivability. The AAAV Program Survivability Division is responsible for the survivability of the vehicle from NBC, fire, ballistic, and armor threats, but not for the survivability of embarked crew or passengers. The underlying premise appears to be that system safety and survivability equate to personnel safety and survivability. Fratricide, though, is specifically addressed by the AAAV Program, but is divided between the Survivability and the Combat Systems Divisions.

5. Program Documentation

Analysis of program documentation highlights the areas in which the Marine Corps places the emphasis of its HSI effort. Specifically, documentation analyses by Marine and DoD oversight agencies show the importance affixed to MPT issues and the descending significance applied to human factors engineering, systems safety, and health hazards.

The AAAV Program Human Systems Integration Plan, developed under the direction of the NAWCTSD MPT Specialist, demonstrates this tendency. A courtesy review of the program documents by the MARCORSYSCOM Program Analysis and Evaluation Office revealed that the HSIP did not adequately comply with DoD policy. The basis of the HSIP was determined to be a MPT Plan developed in 1989, following the guidance of DoD Directive 5000.53. Instead of reformatting the plan in accordance with DoD Directive 5000.2 and SECNAVINST 5000.2A, a cross-referencing matrix to the new format requirements was inserted to retain the character of the original plan. However, upon review, the matrix failed to indicate any human factors engineering, health hazards, and safety considerations.

The PA&E review also indicated the lack of any System

Safety Program requirements, as stipulated in DoD Instruction 5000.2, Part 7, Section, in the HSIP. The assessment cited the unknown safety risks inherent in the program as a critical concern. To emphasize its importance, the report explained the benefits of proper consideration of safety issues in the HSIP. It stated:

> ... a Government Human Systems Integration Plan that properly includes System Safety, would ensure that proper safety-related analyses are conducted and that management decisions include proper consideration of safety. An example is the draft Type A-Specification, which includes several safety-related requirements. The System Safety Plan should include a description of the safety-related considerations of the process that lead to the draft Type A-Specification. Without reviewing this management process, there is uncertainty about the quality of the safety requirements.

The DoD Inspector General's Office reconfirmed this deficiency in its 1993 audit report. The report concluded that the AAAV Program had not adequately performed assessments of the effects of a hot, NBC environment on human performance. The report recommended that the Assistant Secretary of the Navy (Manpower and Reserve Affairs) review and comment to the AAAV DRPM on the program's HSIP. The review, it was recommended, should determine whether the HSIP adequately addresses human factors. Comments would then be provided to the DAB Milestone I decision. Concurring, the ASN(RD&A) further proposed to give other Army and Navy organizations an opportunity to review the HSIP.

In June 1994, a MARCORSYSCOM Logistics Review Group presented the finding of its assessment of the AAAV Program for Milestone I decision. The LRG uncovered four level II (major) findings, one involving an HSI issue. The program documentation was found to "not indicate any efforts in the functional area of system safety engineering during Phase 0,

Concept Exploration and Definition." (Program Support, 1994, p. 1) Remedial action was subsequently taken by the program office to provide a narrative which addresses the system safety program, as well as the safety issues addressed to date. An additional LRG finding regarding the lack of a human engineering program was submitted and later withdrawn when sufficient documentation was presented by the PMO.

In defense of their HSI efforts, the AAAV program office points to the considerable human assessments already conducted. These include:

> ... Early Operational Assessments (EOAs) of each contractors full scale mockup by Fleet Marine Force Marines, HARDMAN Analyses, vehicle accommodation analyses using JACK... Vision Path analyses, Anthropometric analyses, EDCAS analyses, Partitioning analyses, Control and Display analyses using Supercard and Hypercard... workload analyses using CREWCUT..., and finally numerous and extensive AAAV concept design user-jury analyses using experienced Marines. (DoD, 1993, p. 62-63)

Based on this work and the expressed commitment of the PM to the needs of the system operator, the AAAV Program does not appear deficient in its performance of HSI analyses, but rather in its capability to adequately document its efforts.

The Predator Program has produced even less documentation of its HSI efforts. Aware of the HSI requirements within DoD Directive 5000.2, the PMO did not develop a HSIP. Lacking Service or Acquisition Command guidance on the implementation of DoD acquisition management policies, the PM believed that HSIPs were only applicable to ACAT I or II programs.

This understanding was prevalent throughout MARCORSYSCOM prior to publication of MCO 5000.22. Acquisition practitioners previously assumed that ACAT III and IV programs would have little or no effect on MPT, and did not require HFE or health and safety analyses. Therefore, based on the direction of DoD Instruction 5000.2, Part 2, Paragraph C.3, to

tailor the acquisition procedures and documentation for programs less than ACAT I, HSIPs have traditionally not been developed for non-major programs. However, since MCO 5000.22 does not alter the requirements established in SECNAVINST 5000.2A or DoD Instruction 5000.2, HSIPs are now required of all programs in accordance to their magnitude. Consequently, the Predator Program is now developing an HSIP in preparation for Milestone III review.

Because the Predator is not to be aligned with any organizational structure, the PMO determined not to perform HARDMAN analyses. Yet, while at the present time the system is projected to be a non-dedicated weapon available for Service-wide use, the potential exists that the Predator will be utilized to supplement procurement of the Javelin system for infantry battalion anti-armor platoons. In describing the inter-organizational communications required for the determination of changing manpower requirements, a program staff member stated:

> We [PMs] do not specifically get into how many additional people may be needed. The system is hopefully designed so that there is enough information getting to the manpower people through the different channels so that they see that they will need additional people in that field.

While not necessarily indicative of an ineffective system, the above statement illustrates the inconstant nature of the current HSI procedures for non-major programs.

6. Integration

The HSI procedures employed within the Marine Corps are based primarily on the staffing of program documentation for review and comment by HSI practitioners. Marine Corps Order P3900.15, "Marine Corps Combat Development Process," makes continual reference to the staffing of program documentation. For example, under current procedures ORDs are staffed through

the various disciplines separately, and then compiled at PA&E for return to MCCDC's Requirements Division. At no time do the representatives of the HSI disciplines convene to collectively address the performance thresholds to be established in the ORD. Such staffing procedures negate the advantages gained from having MARCORSYSCOM, MCCDC, and MCOTEA collocated on the same base.

The AAAV Program achieves limited integration through group discussions during IPRs. The Predator Program relies exclusively on staffing procedures. The PM acknowledged that staffing is "after-the-fact type management," whereas working groups present a proactive approach to programmatic decision-making. He concedes that "there are just so many working groups you can have, and you never get the right persons anyway."

Tellingly, in May 1993, a Milestone II decision LAR identified two level II (major) findings, both involving staffing. The first concern was that the system laser ranger had not been reviewed by the Navy Laser Safety Review Board. The second issue was the failure of the MTP and ILST documents to be staffed through MCCDC, HQMC (Manpower and Reserve Affairs), or the formal schools which are to instruct the Predator program.

One LEM, knowledgeable of DoD's HSI requirements, admitted that integration is not being accomplished under current MARCORSYSCOM practices. He asserted that whatever integration is being conducted is performed through unstructured liaisons between HSI support personnel. While promoting the increased involvement of HSI personnel with procurement programs, he was reluctant to advocate the establishment of a HSI Branch. Like other acquisition practitioners interviewed, he expressed concern over the additional administrative burden that may be incurred by applying HSI and developing an HSIP for non-major programs

and/or programs anticipated to have minimal alterations. Several persons espoused the opinion that the Marine Corps' acquisition organization was either too 1) short of personnel, 2) short of funding, or 3) reliant on the Army acquisition structure to adequately address, develop, or institute innovative acquisition procedural reforms. This mind-set could potentially impede any efforts to reform the current HSI procedures.

7. Contractor Involvement

The Marine Corps acquisition process again demonstrated inconsistency in the inclusion of HSI as source selection criteria. Currently, the AAAV Program is incorporating HSI criteria into its source selection evaluations. A logistics representative to the Source Selection Board has included human factors questions drawn from the system specifications into the source selection criteria. Conversely, the Predator Program has not included any HSI criteria.

Despite procedural differences, both programs have gained a high degree of contractor involvement in the HSI process. Contractor participation appears to be based in large part on the demonstrated commitment and dynamics of the Program Management Office for the consideration of human issues.

Founded on the interpersonal chemistry and personal dynamics, the success of the AAAV Program's HSI efforts, according to one practitioner is based on "communications, communications, communications." He argues that the program's strength is in its ability to assemble HSI representatives, debate points of contention, and then establish a unified position. After building constituencies within the logistics staff, program office, and external Navy and Marine Corps agencies, the program then presents a forceful, unified front to contractors in requiring HSI consideration. The consequence of such visibility, according to the PMO staff member, is that contractors' designs have had to focus on such

concerns as maintenance accessibility, crew and passenger seating, simplification of controls and displays, visibility, crew workload, and ventilation.

H. SUMMARY

The Marine Corps HSI program achieved an average compliance percentage of 49.7 percent. Earning a total of 138 points out of a possible 280 points, the Marine Corps HSI program was rated as standard in relation to other HSI programs and in satisfying the HSI requirements of DoD Instruction 5000.2. The AAAV Program earned a total of 155 points and a slightly-above standard compliance percentage of 55.3 percent for its HSI efforts. With 121 total points, the Predator Program was slightly-below standard with a final compliance percentage of 44.1 percent.

Analysis of these scores demonstrates that while satisfying the basic requirements contained in DoD Instruction 5000.2, the Marine Corps is not achieving optimum integration of HSI disciplines. Consequently, the Marine Corps HSI process is not systematically identifying human issues and/or trade-offs so that acquisition authorities can make informed decisions to optimize total system performance or minimize life-cycle cost.

Mirrored in these scores are also the strengths and deficiencies of the Marine Corps' HSI policies and procedures. The demonstrated strengths include the following:

- Program Manger empowerment and autonomy in the application and tailoring of HSI;
- Limited bureaucratic requirements restricting the PM's ability to efficiently manage his program;
- Institutionalized culture emphasizing the consideration of the system operator and maintainer during the acquisition cycle;
- Program Manager operational awareness to the needs of the end-user based on recurrent operational experience.

Conversely, the following deficiencies were also identified:

- Lack of senior-level proponency for HSI;
- Insufficient command policies or procedures standardizing the application, performance, or support of HSI;
- Limited involvement of the system proponent in the acquisition decision-making process;
- Inadequate program documentation audit trails to identify and track HSI issues, decisions, and trade-offs;
- Prevalent misunderstanding of HSI principles and terminology;
- Reliance on "stove-piped" staffing procedures, vice integration, to identify and address HSI issues.

In general, the Marine Corps HSI program demonstrated a high degree of variability in the application, performance, and support of HSI. Personality-dependent, the effectiveness of the HSI program is based primarily on each PM's individual knowledge, experience, and initiative. These characteristics stand in stark contrast to the more centralized and systematic procedures of the Army's MANPRINT, which are reviewed in the ensuing chapter.

VI. U.S. ARMY HUMAN SYSTEMS INTEGRATION CASE ANALYSES

A. INTRODUCTION

The current status of the Army's HSI program is best epitomized by the theme of the 1994 MANPRINT Practitioners Conference -- "MANPRINT -- The Expanding Challenge." The title embodies the conflicting features which characterize the MANPRINT program: 1) its steady expansion in scope and application, and 2) the persistent threats to its existence in an era of military down-sizing. The HSI Attributes Matrix contained in Appendix A and described in detail in Chapter V measures the MANPRINT program's success in balancing these opposing forces and achieving effective HSI. Table 6-1 provides a synopsis of the Army's results.

HSI ATTRIBUTES	AGS		AAWS-M	
	Score	Percent.	Score	Percent.
A. Organizational Policy	38	14.8	35	13.7
B. Organizational Oversight	41	16.4	36	14.4
C. Organizational Support	31	15.7	32	16.1
D. Program Application	106	30.4	100	28.7
TOTAL PROGRAM EFFECTIVENESS	**216**	**77.3**	**203**	**72.9**

Table 6-1 Total Army HSIAM effectiveness values by HSI attribute category.

This chapter analyzes the HSIAM effectiveness scores achieved by the Armored Gun System and Javelin programs in their application of MANPRINT methodology. After reviewing each program's current status, the chapter examines the information and insights that were used to assign specific scores. To avoid redundancy, the chapter references, rather

than reiterates, relevant organizational policies and procedures cited previously in Chapter IV. Ultimately, based on aggregate mean scores, the chapter draws conclusions as to the overall effectiveness of the MANPRINT program for comparative analysis in Chapter VII.

B. PROGRAM OVERVIEWS

1. The Armored Gun System Program

The XM8 Armored Gun System is a direct-fire, lightly armored, mobile gun system intended to improve tactical mobility, lethality, and survivability over its predecessor, the M551A1 Sheridan. Designed to provide fire support for light contingency forces and other light armor operation requirements, the system emphasizes rapid strategic mobility through air transportability. The AGS is required to be Low Velocity Air Drop (LVAD) capable and roll-on/roll-off air transportable. Basing the design on Non-developmental Item (NDI) components, the system is to incorporate the following technologies:

- XM-35 soft recoil 105mm cannon;
- Main gun auto-reloader;
- Lightweight titanium hatches;
- Dual axis stabilization turret and sight;
- Redundant commander/gunner controls;
- Roll-out powerpack.

To increase survivability, the AGS will additionally possess three levels of armor protection which the three man crew must be capable of removing or installing within three hours.

Assigned ACAT II designation, the AGS Program is managed by the Project Manager, AGS, Warren, MI. In May 1992, the program successfully completed Milestone I/II Review. Subsequently, in June 1992, the EMD phase contract was awarded

to FMC Corporation, Ground Systems Division, later renamed United Defense, L. P., of Santa Clara, CA. The contract called for a ballistic structure, six test vehicles, and technical data. The program completed its Critical Design Review in September 1993 and anticipates equipping the first unit by December 1977.

2. The Advanced Anti-tank Weapon System - Medium Program

In 1984 the Army approved the concept of the Advanced Anti-tank Weapons System - Medium, also known as the Javelin, to replace the Dragon Anti-tank Weapon System. Employing "fire-and-forget" and top-down attack technology, the Javelin's mission is to provide Army and Marine Corps dismounted infantry units with increased lethality against conventional and reactive armor. The system is required to be a man-portable, shoulder-fired, medium anti-tank missile system capable of defeating modern and future threat armor. Major improvements over the Dragon system include increased range and lethality, increased gunner survivability, reduced launch signature and effects, and decreased support requirements. The Javelin is comprised of two major components: a reusable command and launch unit (CLU) and the missile, sealed in a lightweight, disposable launch tube assembly.

The Javelin Program is managed by the AAWS-M Project Office, Redstone Arsenal, AL, under direction of the Program Executive Officer for Fire Support. Categorized as an ACAT I D program, the system will be procured under the Army Streamlined Acquisition Process (ASAP). A team comprised of Texas Instruments, Incorporated and Martin Marietta Corporation, jointly titled Joint Venture, is contracted to produce the system from EMD through full rate production.

The Javelin Program completed a 54-monthly engineering and manufacturing development phase and entered low rate initial production in FY 1994. Production deliveries are

projected to begin in 1995 and extend through 2006. Total program costs, to include Research, Development, Test and Evaluation, and Procurement Appropriations, are estimated at $4 billion for 58,000 missiles and 5,000 CLUs. (DoD IG, 1991, p.1)

C. ORGANIZATIONAL POLICY

In HSIAM category A, the MANPRINT program was judged as above-standard (7.1) for its organizational support of HSI, based on the consistently above standard scores achieved by the AGS and Javelin programs (7.4 and 6.8 respectively). The advocacy of senior officials for the MANPRINT program is clearly reflected in the Army's well-defined HSI policies and procedures and by the formal incentives instituted to mandate its performance. However, due to the restrictive nature of such organizational policies, the Service's Program Managers possess less autonomy in the management of their programs.

1. Proponency and Policy

Since its inception under the patronage of General M. R. Thurman, the MANPRINT program has received the active support of the Army's senior leadership. Both the DCSPER and the civilian SES MANPRINT Director are vocal proponents for the program. At the 1994 MANPRINT Practitioners Conference, the Military Deputy to the Assistant Secretary of the Army (RD&A) and the Assistant DCSOPS also praised the program and pledged their continued support. Every MANPRINT practitioner interviewed in the course of this research reaffirmed the Army's strong commitment to MANPRINT. One practitioner stated:

> Since 1984, MANPRINT has been a buzzword throughout the Army. But it has also been more than that. It has gotten people really thinking about the soldier and considering him throughout the various aspects of design.

The Army demonstrated its commitment to the principles of HSI through its establishment and empowerment of the MANPRINT Directorate, and the subsequent publication or Army Regulation 602-2. To implement DoD Directive 5000.53, the regulation prescribes policies and procedures, and assigns responsibilities for the MANPRINT program throughout the Department of the Army. Additionally, AR 602-2 establishes the requirement and format for the SMMP and outlines the functions of MANPRINT during each phase of the acquisition cycle.

For major programs, AR 602-2 explicitly defines the responsibilities of those tasked with the performance, support, and assessment of HSI. Most practitioners interviewed demonstrated a strong understanding of the organizational roles and relationships involved in the MANPRINT process. One PMO staff member acknowledged that occasionally debate arises regarding the delineation of MANPRINT issues from technical program issues. Nonetheless, he concluded, "We have all the policy we need."

Slight discord was apparent regarding the policies for non-major programs and the procedures for executing MANPRINT's newest domain, soldier survivability. At their annual conference, several MANPRINT practitioners raised the issue of who is responsible for the assessment of ACAT III and IV programs and to what degree are those assessments are to be performed. In response, the Army Material Command, who is delegated oversight responsibility of non-major programs has subsequently earmarked HRED to perform the assessments. Presently, HRED is designating responsibilities and defining the methodologies to determine which systems will require assessment.

Introduced in 1992, the soldier survivability domain continues to experience growing pains as the roles and responsibilities for its execution are clarified. In 1993,

the AGS was one of two acquisition systems to initiate survivability test assessments. Nonetheless, the AGS MANPRINT Manager maintains that because soldier survivability issues were previously dispersed among the other domains, responsibility for its execution remains clouded by bureaucratic conflict. In 1994, AR 602-2 was amended to address the organizational responsibilities proscribed to the soldier survivability domain.

To ensure the adequacy of program-level HSI efforts, the Army institutionalized several formal incentives. The first of which is the direction to Program Executive Officers in AR 602-2 to "rate assigned PM execution of MANPRINT responsibilities and consider such ratings in PM performance appraisals." A second incentive is the MANPRINT assessment process that was outlined in Chapter IV. The process requires that major programs submit their HSI programs for evaluation by the MANPRINT Directorate. The findings of these assessments are then presented before the Army Systems Acquisition Review Council by the DCSPER or his representative. Because negative assessment findings can adversely affect program progress, PMs are vigilant of their HSI efforts.

During the 1994 MANPRINT Practitioners Conference general concern was express that MANPRINT assessments were not being adequately performed for non-major programs.[15] Several practitioners stated that no "hammer" existed to enforce the utilization of MANPRINT methodology within AMC. Instead of advocating the institution of further incentives, the MANPRINT Director encouraged the practitioners to demonstrate the cost-and-operational-effectiveness of the MANPRINT program to their respective PEOs and PMs. A senior HRED representative echoed

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[15] HQ, AMC, HQ, TRADOC, and other applicable MACOMs are responsible for assessments of non-major programs.

this sentiment and broadened it to address the elimination of restrictive military acquisition regulations occurring throughout DoD. He confirmed that "the hammers are going away." Consequently, he said the philosophy of Army MANPRINT regulations is to tell the PMs what to do - not how to do it. Therefore, he concluded, it is incumbent upon HSI practitioners to continuously prove the value of the MANPRINT program to their senior acquisition officials.

2. Program Manager Restraints

The MANPRINT program received its lowest score in any HSIAM category in the area of PM autonomy. Rated as slightly-below-standard (4), the MANPRINT policies were found to lessen the authority of the PM to efficiently manage their programs.

The MANPRINT assessment process was the primary target for criticism. While program staff members generally praised the HSI support provided by the MJWG members, discontent was expressed concerning the ability of external agencies, specifically the DA MANPRINT Directorate and the OSD HSI Division, to negatively influence programmatic decisions. Several of those interview related stories of instances where requirements imposed by the MANPRINT Directorate adversely affected program cost, schedule, and/or performance.

One acquisition practitioner characterized the assessment process as an organizational culture in which many senior-staff personnel can say "no" to program initiatives, but few can say "yes." He stated, "You do not need bureaucrats to enforce MANPRINT; enforce it through the working groups and through the design, and have the PM answer for his MANPRINT initiatives -- where he succeeded and where he failed." This animosity, its causes, and its effects are discussed in detail later in the chapter.

While restraining PM autonomy, the Army's MANPRINT policies provide Program Managers with systematic and standardized procedures for the performance of HSI. Through

AR 602-2, PM's are guided in the development of their programs' HSI effort, and granted flexibility in the tailoring of that effort to the nature and magnitude of his program. Thus, earning the MANPRINT program only a slightly-below-average effectiveness score.

D. ORGANIZATIONAL OVERSIGHT

Visibility earned the MANPRINT program a well-above standard score (7.7) in the HSIAM category for organizational oversight. Respectively, the AGS and Javelin programs received well-above standard (8.2), and above-standard (7.2) scores. Two factors prevailed. First, from the outset of the acquisition cycle, the user proponents for both the AGS and Javelin systems were actively involved in the HSI decision-making process. Secondly, the MANPRINT program instituted a traceable audit trail for the identification and tracking of HSI concerns. Supported by this documentation, the MANPRINT program's assessment and enforcement process was consequently determined to be highly effective despite the animosity it fosters.

1. User Proponent Visibility

The Army's acquisition procedures ensure that the proponent for the system operator and maintainer, the TRADOC System Manager (TSM), is informed and involved throughout the design and development process. Upon approval of the Mission Needs Statement, Milestone 0, the TRADOC proponent service school is responsible for convening the MANPRINT Joint Working Group and subsequently initiating the System MANPRINT Management Plan. Thereafter, the TSM serves as a reminder to the PM of the needs of the soldier who will employ or maintain the system. A PM observed:

> It is up to my user [the TSM] to ensure that I do not forget. If I get too busy with cost, schedule, or performance, he remind me that he is the customer and does not like a certain aspect of my program.

The TSM is kept continuously informed of system developments through the PMO. One program staff member illustrated the extent of this process by stating that "we don't sneeze unless we tell the TSM what we are doing; it is critical that someone from the school is nodding his head on little decisions." Additionally, as a permanent member of the MJWG, the TSM or his representative attends all MANPRINT meetings and is a key component of the program's HSI decisions-making process. To comply with user's needs and forestall miscommunications, one practitioner said, "The user representative is at the contractor's plant watching every single wart emerge on the skin of the system; every cost problem, every schedule problem, and every design problem."

The AGS Program was credited with an outstanding HSIAM score (9) for taking the additional step of expanding its PMO staff to include a Armor Master Gunner and a Armor Mechanic Non-Commissioned Officer. In this way, the program draws upon in-house expertise to obtain immediate and continuous information regarding the capabilities and needs of the system operators and maintainers.

The Javelin Program, likewise, brought in anti-armor expertise to compliment its development efforts. Early- on, the PMO enlisted the TSM and additional trainers from the Anti-Armor School, Fort Benning, GA, into the MANPRINT effort. These representatives were tasked to construct potential battlefield scenarios for the proposed system to guide the contractor's design process. The benefit, according to a civilian HSI practitioner, was that both the PM and contractor were provided with immediate insight into the users problems and concerns.

2. HSI Audit Trail

The second demonstrated area of excellence within the MANPRINT process is its HSI documentation and tracking procedures. *From program initiation to fielding, the MANPRINT*

program maintains a systematic process to document, address, and track to resolution HSI issues identified by the user, the TSM, the PMO staff, HSI support agencies, or the prime and subcontractors.

The cornerstone of this effort is the System MANPRINT Management Plan (SMMP). Comparable to DoD's HSI Plan, the SMMP is a living planning and management guide. It is used by all activities involved in the material acquisition process to ensue that HSI issues are addressed throughout the system's life-cycle. AR 602-2 defines the mission of the SMMP as follows:

> The SMMP provides an audit trail. The SMMP will document the data sources, analyses, trade-offs, and decisions made throughout the acquisition process. The plan serves as documentation of what was considered and why it was or was not used.

In addition, the SMMP is a source of HSI continuity for the MANPRINT effort. New personnel can review the SMMP and determine why and what tasks, actions, and analyses have or have not been scheduled and performed, what actions must be coordinated and scheduled, and who is involved in the effort. (AR 602-2, p. 11, 1990) Appendix F contains a sample format for a SMMP.

As a living document, the SMMP is revised as new MANPRINT information or concerns are identified. But due to the swift pace of system design and development, SMMP revisions were found to lag behind the MANPRINT process. To stay abreast of immediate HSI issues, the AGS and Javelin programs both rely on the minutes of their MJWG meetings. To enhance the effectiveness of its HSI audit trail still further, the AGS program developed an additional tracking tool -- the MANPRINT Log. A civilian HSI consultant explained the documentation procedures as follows:

> The MANPRINT Log tracks issues so they are not swept under the rug which is easy to do in a massive, complicated systems development program. We track each issue individually through the point of resolution... Once an item is on the tracking system it stays there until it is either closed out by the Government or the contractor says 'That is all I can do for it' and the something has to be resolved.

The MANPRINT Log is contained in two documents: the Detailed Log and the Summary Log. The Logs delineate the aspect of the system in which an HSI concern exists, a description of the concern, its origin,[16] its status,[17] its influence on system design, and the MANPRINT domain effected. The MANPRINT Log is maintained and updated on a computerized data base by the prime contractor.

Prior to prototyping, the AGS MANPRINT Log grew to 247 issues ranging from Troop Commander visibility ranges to Driver's hatch accessibility to seat cover durability. The AGS MANPRINT Manager explained that the identification of so many HSI issues is a mixed blessing, analogous to a glass being viewed as half-full or as half-empty. He said, "We consider our glass half-full because we have identified issues that can then be resolved by either taking action or doing nothing." However, he said, some outside observers view the documentation of that many issues as "a crisis," as the glass being half-empty. "That is malarkey," he asserted, stating that it is preferable to be aware of the issues and deal with them to fail to identify them.

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[16] Origins include: 1) System Hazard Analysis, 2) Product Design Team, 3) User-Juries, or 4) Micro Analysis and Design.

[17] Issue status may be 1) unresolved, 2) resolved, 3) completed by contractor, or 4) closed by the Government.

3. HSI Review and Assessment Process

MANPRINT's through documentation procedures also enhance the effectiveness of its assessment process by providing outstanding visibility into the HSI decision-making process. For the PMs, however, this too often proves to be a dual-edged sword. For major and Level I non-major programs, the DCSPER MANPRINT Directorate is chartered to:

> Review and monitor material objectives, requirements documents, System MANPRINT Management Plans, acquisition strategy documents, and other pertinent acquisition related documents in material development or improvement to ensure that MANPRINT is addressed early and continuously in the development of total system performance requirements.

Thus, a former Assistant PM stated, the MANPRINT assessors armed with program documentation "smite us with our own arrows." A MANPRINT assessor confirmed that "we do most of our work off of paper; whatever documents people [PMO] give us is all that we get."

The MANPRINT process was judged highly effective at identifying and evaluating HSI issues at both the program and Department of the Army levels. Yet, while those interviewed commended the communicative and cooperative nature of lower-level MANPRINT reviews, several practitioners commented negatively on the detachment of the DA and OSD HSI assessors. A former program staff member illustrated the situation as follows:

> It is like someone coming up to Michelangelo after 15 years of working on a statue and pointing out a flaw. 'It is a really nice statue, but you have a chip on his elbow. Could you recut the whole thing out of a new block of granite?' You have spent $500,000,000 on the development of a new missile system. You have made the painful trade-offs as you went through. Then, on the last minute of development in a 54-month program, a critic walks

> in and says, 'You have a chip on the elbow. How are you going to fix it?'

The primary criticism leveled against the MANPRINT assessors was that, in general, they lack operational expertise with the systems they are tasked to judge. Asserting that the Army "does not need a MANPRINT police force," one acquisition practitioner stated:

> What we have at DA and OSD is offices staffed with people, who have never had to design or produce a system, and in most cases have never used a system in any type of operational environment, passing judgement on the technical, budgetary, and scheduling efforts that have been made by hundreds of highly qualified people from Government and industry. On the eve of production, they are standing at the gate passing critical judgement.

These critics expressed the concern that MANPRINT assessors lack the experiential insight gained by employment of the system or direct interface with the users and design engineers. Further, such critics charge assessors second-guess the PM's decision-making process and, unlike the PM, are not held accountable for the consequences of their judgements.

MANPRINT assessors counter that it is their impartiality that allows them to evaluate systems based on the best interests of the soldier and the Service. Several assessors expressed the opinion that the MANPRINT Directorate is often a stronger soldier's advocate than the user. One assessor stated:

> The school house is supposed to be the representative of the user, but in a lot of ways I do not think they do as good a job as they could. They are occupied developing training plans, and do not have the time to be the advocate for the soldiers. I see the MANPRINT practitioners as the advocates for the soldiers.

Another assessor contends that PMs do not ignore HSI

intentionally, but rather do so from lack of HSI expertise. He stated that "the vast majority of PMs want to help the soldier and produce a quality produce, and we just try to steer them in the right direction."

Frequently, the DA-level assessor defend such HSI issues as heat- and combat-load limitations that the user, by overestimating soldier prowess, disregards as inconsequential. For example, in the case of the Pedestal-Mounted Stinger, the Directorate identified a potential problem with extreme climatic conditions denigrating the soldier's capability to operate the system. Arguing that the soldier could sustain the heat conditions without undue difficulty, the user authorized production to continue. When deployed during Operation Desert Shield, heat stress again became a critical issue. Due to the user's subsequent requests contracted engineers were deployed to Saudi Arabia to perform costly in-place system modifications.

A similar debate centered around the weight of the Javelin. Initially, the Javelin Program established a system weight threshold of 45 pounds with a desired weight of 35 pounds. Later it became apparent that the system could not meet its weight threshold without sacrificing significant technical capabilities desired by the user. In December 1991, a DoD IG Audit Report, "Acquisition of the Advanced Anti-Tank Weapon System-Medium," addressed the weight issue. The report contented that at 49.5 pounds without the inclusion of the replacement batteries for the Command Launch Unit (2.25 pounds) or the Launch Tube Assembly (1.06 pounds), the Javelin was too heavy to be one-man-portable. The report determined that:

> The Javelin could be carried by only five percent of the soldiers if the system's weight was 35 to 42 pounds, and could not be carried by a soldier without risk of injury to the soldier or degradation of the soldier's mission if the

> system's weight exceeded 45 pounds. (DoD IG, 1991, p. 16)

Finally, the DoD IG's Office questioned whether the Javelin would be operationally effective and suitable for use by light infantry and airborne forces.

Citing that "MANPRINT tried several times over the years to surface the [weight] issue, but was largely unsuccessful," one HSI assessor stated that the "PM blew aside human considerations." The assessor asserted that Program Managers frequently get caught up in the appeal of "sexy technology," and in cost, schedule, and performance considerations, and consequently disregard human issues as too mundane.

A former Javelin Program APM contests this observation. He states that the user was continually informed of and knowingly accepted the HSI trade-off between system weight and state-of-the-art technology. Following JROC review, an Acquisition Decision Memorandum was issued establishing a new weight threshold at 49.5 pounds with the provision that if the system exceeded this limit the program would be subject to termination. "When the user formally said he would accept 49.5 pounds, that should have been the end of any argument from the MANPRINT people," said one PMO member. "When you have done the best you can, you do not need some critic walking in at the end and saying 'No, that is not good,' especially when the customer is there ready to accept the system."

However, to preclude further confrontation with HSI oversight authorities, the customer, represented by the TSM, subsequently redefined the term "one-man-portable to refer to Javelin's single man operation, not to its method of transport. Further, reiterating his concern for the soldier, he pledged that he would ensure that the weapon system was employed properly once it was fielded. Additionally, the PMO redoubled its weight management efforts. "We [PMO] gave up things like the bipod, shaved every bit of weight we could

from the launch tube... and spent millions of dollars on the latest in synthetic and graphite components," a staff member explained.

Both sides of the debate concede that the earlier and more actively MANPRINT assessors are involved in the program procurement cycle the better and less adversarial is the inter-organizational communications. This is especially true for non-major programs which are subject to less oversight, and whose MANPRINT assessment efforts are therefore more dependent on the PM's initiative. A PERSCOM representative stated:

> Category III programs are our weakest area. We try to assess high visibility programs, but it comes down to how interested the PM is in seeking our help. We do not have the resources to address all the ACAT III programs.

The current policy of the AGS and Javelin programs is to maintain a periodic dialogue with the MANPRINT assessors. In that way, the assessors are continually aware of the program's status, and can make better informed judgements.

The MANPRINT program achieved an above-standard grade (7.5) for its capability to effectively enforce the correction of HSI issues. MANPRINT's power of enforcement resides in the authority vested in the DCSPER as a standing member of the ASARC. Representing the MANPRINT domains, the DCSPER can present unresolved or inadequately addressed HSI issues before the Council, and thereby influence the AAE's decision to grant Milestone Approval. As one MANPRINT practitioner asserted: "MANPRINT has teeth. It has a three-star General that votes on the ASARC, and can kill a system."

4. Feedback Mechanisms

User-juries, or mock-up reviews, were the key feedback mechanism employed by both the AGS and Javelin programs to evaluate the effectiveness of their HSI efforts. In 1992, the

AGS PM was commended by the DCSPER for "his use of 'user-juries' to evaluate proposed solutions during source selection and to provide close scrutiny during periodic design reviews." To date, the AGS Program has conducted two user-juries.

The first user-jury was conducted in August 1992 before hardware design was finalized. The user-jury, which consisted of both operators and maintainers, was credited with aiding the contractor's understanding of the user's requirements, influencing system design, and creating an up-front focus on MANPRINT.

During this user-jury, 74 MANPRINT issues were identified of which 67 were raised by soldiers from the 3-73 Armor Unit. Of all the issues, 61 were subsequently incorporated in to the system's design to include the following:

- Dual turret control panel incorporated for ease of use;
- User input on computer control panels to make user friendly;
- Driver hatch redesigned for ease of ingress/egress for crew;
- Belly plate redesign for ease of maintenance;
- Guards provide for engine cables for service durability.

By mutual consent, 13 remaining issues were not incorporated.

The second user-jury was conducted from 25 April to 13 May 1994, following prototype fabrication. The purpose of the user-jury was to validate all possible MANPRINT design requirements from the purchase description and verify the operator logistics package. Employing soldiers with ranks from Sergeant to Master Sergeant and 8 to 21 years of experience, the jury succeeded in validating all the Training Manual operator and maintenance tasks, and commenting on 361 MANPRINT issues.

The AGS prime contractor, United Defense, L. P., also

actively sought out the soldier's perspective for its AGS demonstrator, the Close Combat Vehicle-Light (CCVL). The CCVL design benefitted from a six-month user evaluation conducted from November 1987 to April 1988 during the Customer Test of the Manned Turret Demonstrator. The company claims that "continually refining our product, we proudly offer a soldier-driven AGS design."

One criticism lodged against the Army user-jury process is that it may not adequately reflect the capabilities of regular soldiers. In a Memorandum for the Record regarding Javelin weight and portability issues, the OSD HSI Division stated that the Army's Office of the Surgeon General requirement for only volunteer soldiers to be used in system testing may inhibit a true assessment of typical soldiers. The Javelin TSM concurred with this critique. Additionally, a former Javelin staff member acknowledged an Army-wide practice of using specially-trained personnel from the Training and Doctrine Command for user-juries, instead of selecting soldiers from the field. The AGS Program compensated for this deficiency by intentionally enlisting standard Army units for its user-jury evaluations.

E. ORGANIZATIONAL SUPPORT

The well-above standard effectiveness score (7.9) obtained by the MANPRINT program in HSIAM category C displays more than the Army's abundant organizational resources for the support of HSI. This strong score also demonstrates the Army's development of forums for the analysis of HSI trade-off early enough in the acquisition process to effectively influence system design. Both programs were credited with outstanding scores (9) for their use of MANPRINT Joint Working Groups to integrate human issues into the acquisition cycle.

1. HSI Support Resources

Chapter IV outlined the organizational components of the Army's extensive HSI support infra-structure. For example, the AGS Program's system safety and health hazards domains are supported by no less than eight organizations which include the Armor School, the Army Medical Department Center and School, the Surgeon General's Office, the Tank-Automotive Command, the Armaments Research, Development, and Engineering Center, TRADOC, the Army Safety Center, and the Health Services Command. Another key organization for HSI support is the Army Research Laboratory, HRED, which manages both the Human Research Engineering and the Survivability/Lethality Analysis Directorates.

2. HSI Forums

In organizing its extensive support resources, the MANPRINT program has developed a highly effective tool for the deliberation of HSI issues -- the MANPRINT Joint Working Group (MJWG). The majority of those interviewed praised the MJWG as being the core of the MANPRINT process. Through periodically scheduled meetings, representatives for all seven MANPRINT domains are provided an opportunity to voice their HSI concerns for the consideration of the assembled group. One acquisition practitioner asserted that the strength of the MJWG is that it brings domain specialists, attuned to programmatic concerns, "around the table to make sure that all issues are considered, to watch the design process, and to raise their issues."

Both the AGS and Javelin programs espoused strong support for the utilization of MJWGs. The AGS MANPRINT Manager elaborated that "we are trying to execute what the school-houses require without making it a bureaucratic process; by assembling a conscientious meeting of key player to at least surface and discuss issues." With this objective, the AGS Program redesignated its MJWG a MANPRINT Management Team

(MMT). According to the MANPRINT Manager, the intent of the title change was to remind practitioners that the purpose of the AGS Program was to field a functional system rapidly without being entangled in bureaucratic meetings. To this end, the MMT is chaired by the AGS Program MANPRINT Manager with his industry counterpart serving as vice chairman. Normally lasting two days, MJWG meetings convene quarterly in conjunction with ILST meetings. The MMT agenda includes such items as MANPRINT Log reviews, SMMP revision, and domain status reports and assessments.

The Javelin Program instituted a similar MJWG schedule. In accordance with AR 602-2, the MJWG was initially assembled by the Infantry School, TRADOC, prior to Milestone 0. During the program's recently completed 54-month EMD phase, the MJWG met quarterly coincident with system technical review. The frequency of the meetings is now projected to decrease as the influence of MANPRINT analysis diminishes with the stabilization of system design.

The Army has traditionally emphasized and vigorously supported the education of its soldiers. The MANPRINT program is no exception. While not mandatory, the MANPRINT training courses listed in Chapter IV are offered to U.S. Armed Forces personnel, allied-Service personnel, and industry representatives. To date over 5000 students have attended MANPRINT training. The Army Logistics Management School also makes available to MANPRINT practitioners a wide array of HSI references and publications. Through the persistent efforts of the MANPRINT Directorate, the Army continues to actively expand the sources and curriculum of its MANPRINT training.

F. PROGRAM APPLICATION

1. Overview

"Hell," said one acquisition practitioner, "everyone likes MANPRINT and everyone wants MANPRINT, but to what degree

can you obtain MANPRINT?" Category D, Program Application, answers that question for the AGS and Javelin programs. The average HSIAM effectiveness score (7.4) exhibits the Army's capability to consistently achieve above-standard levels of HSI. Both acquisition programs demonstrated proficiency in the understanding and application of HSI techniques. In endeavoring to fulfill the user's needs, the AGS and Javelin programs excelled in their ability to communicate, secure, and ultimately integrate their human systems requirements.

2. Program Management Commitment

Despite a profusion of MANPRINT slogans encouraging Program Management Offices to "equip the man, not man the equipment," the true well-spring of program-level commitment to HSI appears to be the operational awareness of the military staff. As one practitioner explained: "We have our civilians who provide the institutional knowledge on how to do MANPRINT-specific procedures, and then we have our military personnel who bring in the nuts-and-bolts issues." Another practitioner echoed this opinion citing that civilians maintain the institutional memory, while military personnel maintain the operational flavor and perspective."

Based on prior experience, military staff members provide their programs with knowledge of the operational capabilities and needs of the system operator and maintainer. Confirming the criticality of such operational insight, one HSI practitioner stated:

> ... military personnel are probably more sensitive to the soldier than anyone. They share a kinship with the soldiers and want to look out for their welfare.

Although the Army has established a separate career track for its acquisition professionals, those interviewed were adamant that they had not and would not lose their operational awareness. Reaffirming his alliance to the armor field, the

AGS MANPRINT Manager asserted, "I am still deep down a tanker. I can remember be ugly, cold, and muddy."

The AGS and Javelin programs offices both expressed their firm commitment to the needs of user through their aggressive MANPRINT programs. A Javelin HSI practitioner said that he "could not remember an instance where the PM was hesitant to support or fund any MANPRINT effort." Despite funding and manpower constraints, he continued, the PM never hesitated to ensure that MANPRINT practitioners could attend critical program events. In March 1994, the DCSPER extolled the PM on "his willingness to incorporate design improvements to enhance MANPRINT features." The AGS PM has received similar commendation from external HSI practitioners. A MANPRINT Directorate staff member characterized the situation by stating:

> Our Program Managers know MANPRINT is important. They may not like to do it all the time, but they know it is important. That is why most of them have an Assistant PM specifically for MANPRINT.

In fact, the AGS Program does maintain a military officer in the billet of MANPRINT Manager. According to a MANPRINT assessor, this action was taken because the program initially failed to consider MANPRINT, and subsequently required additional expertise to fix resultant problems. Like the Javelin's civilian MANPRINT Manager, the AGS MANPRINT Manager works within the program's ILS Division. Surprisingly, neither program's MANPRINT Manager has formal MANPRINT training. A graduate of the Material Acquisition Management Course, the AGS MANPRINT Manager derives his HSI expertise from on-the-job training and prior military experience. The recently appointed Javelin MANPRINT Manager possesses previous acquisition experienced as a Logistical Management Specialist. She is currently scheduled to attend the MANPRINT Action Officer Course. So, while both programs maintain managers

specially tasked with HSI management, neither manager is formally trained despite the Army's extensive MANPRINT training program.

3. Program Documentation

The "MANPRINT Quarterly" in its winter 1995 edition stressed that no major conflicts exist between HSI and MANPRINT. Both programs, it states, require management plans; the Army's is the SMMP and DoD's is the HSIP. Consequently, in developing their respective SMMPs in accordance with the requirements of AR 602-2, both the AGS and Javelin programs produced above-standard HSIPs. The SMMPs include analysis of an additional domain, soldier survivability, which is not required in the HSIP and will not be evaluated in this thesis.

Reflecting MANPRINT's historical foundation, the AGS Program's HSI documentation was strongest its analyses of human factors engineering (7.5), system safety (7.5), and health hazards (7.5), and weaker in manpower (6.5) and personnel (6.5). The AGS MANPRINT Manager recognized the competition inherent the HSI arena and acknowledged the dominance of human factors engineering. He stated:

> Human factors has always been a big piece of MANPRINT because Human Factors Engineers have been doing this for years. Every thing else below that became secondary... Human factors considerations overwhelm other domains... Because we have been doing human factors, safety, and heal hazards for so many years, those systems exist and are efficient. Where we [the Army] get loose is in manpower and personnel....

This fact is evident throughout the AGS procurement cycle by the PMO's aggressive efforts to address human factors issues. A 1991 MANPRINT Review by the Human Engineering Laboratory identified a number of deficiencies related to the AGS predecessor system, the M551A1 Sheridan. These issues ranged from inadequate seating, and ingress/egress problems,

to the need for a micro-climatic cooling system. The PMO was later commended by the DCSPER for articulating many of these issues as MANPRINT requirements in the RFP. The program's extensive MANPRINT Log program is further evidence of PMO's continued dedication to surfacing potential human issues. The program's second user-jury alone generated over 360 MANPRINT Log entries.

Interestingly, despite this vigorous effort and the current DoD-wide concern for the heat-load of combat vehicles operating in extreme climatic conditions, the AGS Program did not include a cooling system in its system design. In defending the decision, the MANPRINT Manager stated the system ORD was developed prior to the publication of lessons learned from Operations Desert Shield and Desert Storm, and therefore cooling requirements were not initially included. The ORD was not subsequently amended because, based on the urgency of need for the system and its size and weight constraints to achieve LVAD capability, "the Armor School decided it was not a big requirement." While a cooling system was desired in the RFP, it was not required whereas the LVAD capability "was not to be sacrificed."

The Army Research Laboratory continues to argue for the inclusion of a cooling system requirement. "ARL beats us [PMO] up on it," the MANPRINT Manager said, "and our answer is that it is not a requirement. Make it a requirement, give us some money, and accept a year or so delay in the program and we will provide it."

One AGS staff member displayed dismay at the program's manpower and personnel achievements. He stated that the contractor's MPT analyses provided little information beyond what could have been done derived intuitively. He stated that despite employing the services of three consultants at a cost of over $10,000, the results of HARDMAN III analysis were negligible.

The Javelin Program has similarly focused the majority of its MANPRINT effort into the domain of human factors engineering, specifically in its search to reduce system weight. Each program staff member interview stressed the priority placed on weight reduction. One practitioner said that "MANPRINT's success was in looking at the system and then shaving weight." Weight reduction efforts went as far as decreasing the system's protective foam padding, redesigning the carrying bag's clips and fasteners, and eliminating a prone-firing bipod. Ultimately, though, one practitioner conceded that "no MANPRINT effort, no matter how outstanding, could have overcome the demand for new technologies. To kill a modern battle tank, you have to accept a certain amount of system mass."

In January 1994, the Javelin Program was the subject of an integrated MANPRINT assessment in preparation for a Milestone IIIA ASARC Review. Despite the PMO's best weight management efforts and the Army's and OSD's acceptance of a 49.5 pound weight limit, MANPRINT assessors, nonetheless, rated system weight as an amber (major) human factors engineering issue. The weight issue was also reflected in the manpower domain's amber rating due to the potential requirement for two personnel to carry the system over extended distances.

Reaffirming the domain strengths demonstrated by the AGS Program, no issues were identified in the system safety or health hazards disciplines. The Independent Safety Assessment stated that the PM had an effective system safety program. Further, the Health Hazards Report provided recommendations to adequately control potential health risks. A former APM joked that within the MANPRINT process the health hazards posed by lead toxicity -- equivalent to smoking approximately one cigarette -- was a major concern while lead bullets fired by the enemy were not.

Due to "the synergistic effect of multiple manpower, personnel, and training concerns," the MPT assessment team coded the Javelin Program as red (critical). This rating was based primarily on training deficiencies. Whereas the personnel domain was coded as amber (major) for one concern, its failure to create an Additional Skill Identifier for the Javelin gunners, training was cited in one critical issue and five concerns. The critical issue challenged the adequacy of the System Training Plan (STRAP). The plan failed to fully quantify the training support, personnel, and resources required to upgrade current Dragon facilities to support Javelin training. The Infantry School subsequently projected a $3,000,000 system cost increase. The assessment's five additional training concerns include:

- Weapon back-blast must be identified for training safety as a potential danger for personnel;
- Training to positively identify targets with the CLU/sight at extended ranges (greater than 1000 meters) has not been addressed;
- Javelin will require soldier proficiency in acquiring targets via thermal images, however, there is currently no thermal image training base available;
- The Javelin Manpower Estimate Report (MER) states that the current authorized procurement quantities for each of the Javelin training devices is significantly greater that the Dragon training device quantities;
- The MER and the STRAP have conflicting data about which MOS will maintain the Javelin system.

While noting these criticisms, the MANPRINT Directorate reported to the ASARC in March 1994 that there were no issues that would prevent the Javelin Program from proceeding to low rate initial production.

4. Integration

Examination of the MANPRINT procedures employed by the AGS and Javelin programs reveals that human considerations were effectively integrated between and among the HSI disciplines. Integration was achieved at the program-level through the MANPRINT Joint Working Group and at the Major Command- and Service-level through the MANPRINT review and assessment process. These procedures were found to support both horizontal and vertical integration of human issues. A civilian HSI practitioner summarized this institutionalized exchange and integration of information when he asserted that "MANPRINT is communications."

5. Contractor Involvement

To effectively communicate their MANPRINT requirements to industry, the AGS and Javelin programs relied on the source selection process. The MANPRINT philosophy maintains that the single most reliable indicator to industry that the Army is serious about its expressed commitment to human factors is the degree to which human factors can make a difference whether a contract is won or lost. A civilian HSI consultant reconfirmed the need for contractual documentation of HSI requirements by stating:

> If the Program Management Office emphasize it [HSI] it will get support. If it is strongly stated in the RFP, so that the contractor's proposal strongly emphasizes it, it will get support. If it does not, most of the human factors areas are hard-put to generate support in an engineering environment.

For this reason, the AGS program established the following source selection criteria, listed in descending order of precedence: 1) technical, 2) logistics, 3) MANPRINT, 4) contractor's past performance, 5) cost, 6) management and production expertise, and 7) schedule.

The Javelin Program, likewise, required contractors to

address MANPRINT issues and efforts in their contract proposals. The Javelin prime contractor, Joint Venture, subsequently restated the Army's HSI requirements to the subcontractor through statements of work. According to Joint Ventures, subcontractors in their proposals were required to provide a MANPRINT Program Plan that "outlined how MANPRINT issues were to be addressed and demonstrated their ability and intent to implement MANPRINT into their system design/ product." Hence, as a consequence of including MANPRINT criteria in the source selection process, not only were the Army's HSI requirements contractually formalized, but the contractors were also afforded an opportunity to demonstrate their HSI proficiency.

Joint Venture was praised by members of the Javelin Program staff for its up-front presentation of a conscientious MANPRINT effort. From the outset, Joint Venture offered proposals which explicitly delineated its MANPRINT objectives. Due to this proactive approach, Joint Venture entered the program not only with an effective MANPRINT strategy, but also with the necessary personnel and resources in-place to execute it.

Joint Venture's MANPRINT organization includes dedicated MANPRINT coordinators within Martin Marietta and Texas Instruments. The MANPRINT coordinators are responsible for:

- Overseeing and conducting daily MANPRINT activities;
- Identifying required MANPRINT analyses;
- Coordinating with technical activities to ensure the integration of all six domains;
- Tracking critical MANPRINT issues;
- Ensuring MANPRINT issues are identified, tracked, and resolved in a timely manner;
- Initiating changes in the MANPRINT Management Plan;

- Monitoring the MANPRINT efforts of subcontractors and implementing the MANPRINT subcontract plan;
- Ensuring personnel are properly trained in MANPRINT;
- Ensuring that all engineering change proposals are reviewed from a MANPRINT perspective.

The coordinators are supported by a MANPRINT Working Group (MWG) consisting of technical representatives from each domain. The MWG was responsible for considering the MANPRINT implications of design alternatives and formulating recommendations for enhancing the MANPRINT characteristics of the system design. MWG meetings were initially scheduled monthly for the first year of development and then occurred informally on a weekly basis there after.

United Defense, L. P., entered program negotiations similarly armed with an aggressive HSI program, which it boasts predated the formal emergence of the MANPRINT program. At the start of the solicitation process, the contractor introduced a formal MANPRINT action plan founded on the integration techniques it developed during previous armored vehicle programs. Claiming that its commitment to the AGS MANPRINT program is second-to-none, United Defense, L. P., asserts that its MANPRINT program:

- Optimizes the AGS design;
- Integrates all six MANPRINT domains with AGS concurrent engineering;
- Builds on FMC's (United Defense, L. P.) extensive and relevant experience;
- Uses the right organizations and personnel resources effectively;
- Ensures subcontractor/vendor compliance;

- Manages AGS program data efficiently;
- Provides timely design inputs with full compliance to master schedules.

To achieve these objectives, United Defense, L. P., grants MANPRINT organizational stature equal to the other major program areas. Reporting directly to the system PM, the MANPRINT Manager is likewise equal in status to the other members of the AGS management team. In conjunction with the PM, the MANPRINT Manager is also responsible for monitor the subcontractors HSI efforts.

The firm's MANPRINT philosophy it to promote "communications both between specialists in the six domains and with other members of the concurrent engineering team. Thus, the MANPRINT specialists are collocated with the principal concurrent engineering team. The specialists are further empowered with sign-off authority on all engineering drawings. Integration is facilitated through weekly meetings of the Contractors MANPRINT Working Group. Comparable to the Army's MJWG, the purpose of the CMWG is to surface, address, and ultimately generate a consensus on each domain's MANPRINT concerns. Issues and alternatives are then collectively presented to the design engineers for action. "The key to success is this unified approach," concluded an HSI consultant.

G. SUMMARY

Overall, the Army's MANPRINT program averaged 210 points out of a possible 280 points. Achieving a compliance percentage of 75.1 percent, the MANPRINT program was graded as well-above-standard in its capability to support and execute HSI in accordance with the requirements of DoD Instruction 5000.2. This outcome was based on the consistently strong scores posted by both acquisition programs in each category. The AGS Program with 216 total points earned a well-above-

standard compliance percentage of 77.3 percent. With 203 total points, the Javelin Program was judged as above-standard by virtue of its final compliance percentage of 72.9 percent.

Through analysis of the HSIAM effectiveness scores meaningful insights can be drawn as to the strengths and weaknesses of the MANPRINT program. The major strengths exhibited by the MANPRINT program in its application within the AGS and Javelin programs include the following:

- Senior-level proponency for HSI;
- Systematic procedures, clearly defined through organizational policies, for the application, performance and support of HSI;
- Continuous and active involvement of the proponent for the system operator and maintainer in the HSI decision-making process;
- Traceable audit trail which documents HSI issues from identification through resolution;
- Aggressive HSI review and assessment procedures for the evaluation and enforcement of adequate HSI procedures;
- Structured forums for the identification and integration of HSI issues, and the subsequent formulation of design initiatives to accommodate human capabilities and limitations;
- Inclusion of HSI requirements in the source selection process to formalize and contractually document contractor commitment to HSI requirements.

Additionally, the MANPRINT program exhibited the following deficiencies:

- Limited latitude granted to the Program Manager in the application and execution of HSI;
- Organizational animosity produced by bureaucratic oversight procedures hindering efficient program management;
- Persistent organizational and budgetary threats to HSI resources, funding, and personnel.

Through centralized HSI policy management, multi-tiered assessments, institutional incentives, and standardized procedures, the MANPRINT program achieves consistent and effective integration of human issues into the acquisition process. Minimal variance and optimal integration are the hallmarks of the MANPRINT process. The next chapter will contrast these characteristics against those demonstrated by the Marine Corps' HSI program.

VII. COMPARATIVE ANALYSIS

A. OVERVIEW

In complying with DoD's mandates, the Army and Marine Corps have developed distinctive HSI programs. Each program possesses unique strengths and weaknesses and hence achieves varying levels of effectiveness as illustrated in Table 7-1.

PROGRAM	SCORE	COMPLIANCE PERCENTAGE
Advanced Amphibious Assault Vehicle (AAAV)	155	55.3
Short-Range Anti-tank Weapon System (SRAW/Predator)	121	44.1
Marine Corps HSI Program Average	138	49.7
Armored Gun System (AGS)	216	77.3
Advanced Anti-tank Weapon System (AAWS-M/Javelin)	203	72.9
Army MANPRINT Program Average	210	75.1

Table 7-1 Total HSIAM effectiveness values by acquisition program and Service.

Through comparative analysis, this chapter identifies those Service-unique organizational policies, procedures, and practices which have benefitted or hindered the effective performance of HSI.

B. FINDINGS

The Army and Marine Corps HSI programs reflect the disparate philosophical tenets, institutional cultures, and organizational resources of the Services they are designed to serve. While both programs comply with the specific

requirements of DoD Instruction 5000.2, their HSI methodologies vary according to the operational requirements and constraints imposed by their respective organizational environments. The fundamental characteristics of each Services' HSI program are contrasted in Table 7-2 and are discussed below.

ARMY MANPRINT PROGRAM	U.S.M.C. HSI PROGRAM
Centralized	Decentralized
Systematic	Flexible
Standardized	Diverse
Formal	Informal
Bureaucratic	Personality dependent
Incentives	PM initiative
Oversight	Autonomy
Formal audit trail	Limited documentation
High visibility	Low visibility
Dedicated support	Matrix support
Integrated	"Stove-piped"

Table 7-2 Comparative analysis of the Army MANPRINT program and the Marine Corps HSI program.

1. Proponency

The first and most important area of contrast between the Services is the organizational proponency for HSI and its consequences. The MANPRINT program was conceived and institutionalized under the patronage of senior Army officials, specifically the DCSPER. Recognizing the economic and operational need to improve the consideration of "the soldier in the acquisition loop," senior Army officials centralized the control of the HSI within the MANPRINT Directorate. The Directorate was charted to implement and monitor Service-wide HSI policies. Protected

and sustained by the continued patronage of the Army's senior leaders, the MANPRINT Directorate subsequently established formal, standardized procedures for the application, execution, and support of HSI within the Army. By regulating and incentivizing HSI performance in AR 602-2, the Army consequently lessened the authority and autonomy of its PMs to efficiently manage their programs.

No senior Marine Corps leader, however, has yet championed the cause of HSI. As a consequence, HSI has received only limited organizational attention or support. In response to the publication of DoD and Department of the Navy acquisition policies, the Marine Corps is now beginning to formalize its policies. Lacking senior-level guidance, the Marine Corps acquisition community has not standardized its HSI procedures. Instead, the Corps relies on the institutional knowledge of its civilian work-force and the conscientiousness of its military program staff to perform and support HSI.

The decentralized nature of the Marine Corps HSI program is sustained by the institutional philosophy that because each procurement is unique, the PM should be given unrestricted authority to efficiently manage his program. Thus, decentralization provides the PM not only with flexibility in tailoring his HSI effort, but also with a diversity of options in its execution. However, because decentralization relies on individual knowledge, understanding, and interpretation of DoD's HSI policies by program and support staff members, it results in the inconsistent application, execution, and support of HSI.

The HSIAM scores demonstrate the extent to which each Service achieved consistency in the performance of HSI. Total effectiveness scores for Marine Corps acquisition programs varied by 34 points, whereas the Army scores deviated by only 13 points. For individual questions, Marine Corps scores

displayed up to 5 points of variance, yet Army scores differed by only 3 points. Therefore, by standardizing and regulating the MANPRINT process, the Army achieved greater consistency in the performance of HSI throughout the Service. Conversely, because it is personality-dependent, the Marine Corps HSI program's effectiveness is ultimately based on the initiative and expertise of the PM and his staff.

2. Visibility

Visibility is the second major area of contrast between the Services. The Army MANPRINT program affords outstanding visibility into the HSI decision-making process in two ways: first, through the active participation of the user proponent, the TSM, in the acquisition process, and second, through the development of an effective audit trail to track HSI issues.

As a member of the MANPRINT Joint Working Group, the proponent for the system operator and maintainer is continually informed of HSI issues as they arise, and subsequently involved in the formulation and selection of alternative design solutions. Control and communication of HSI issues is maintained through the SMMP and the MANPRINT Log. These living documents track HSI issues from identification through resolution, ensuring that each issue is considered during the design and development process. This traceable audit trail not only provides structure and continuity to the MANPRINT effort, but also provides senior acquisition and review authorities with insight into the program's HSI issues and actions.

The Marine Corps HSI program offers significantly less visibility into the HSI decision-making process. Due to personnel constraints and current organizational practices, the user proponent, the MCCDC Requirements Officer, is not actively involved in the acquisition process. The PM is only required to inform the user proponent of program decisions during Milestone Reviews or if an ORD threshold will be

breached. External visibility into HSI decision-making is further clouded by the lack of traceable audit trails. Given greater autonomy in the management of their programs, Marine Corps PMs are not required to document HSI issues beyond those HSI requirements established in DoD Instruction 5000.2. Not until August 1994, however, did the Marine Corps formally apply the HSIP requirement to non-major programs. Instead, the Marine Corps left both the control and communication of HSI issues to the discretion of its Program Managers.

3. Oversight

Organizational oversight is the third major area of contrast. The Army maintains a centralized bureaucracy for the review and assessment of MANPRINT procedures. The extent of this oversight is illustrated in what one PM called his first ignominious principle of program management: "While there is a limited number of people in the program, there is no limit to the number of people who review and audit it." Although both the Army and Marine Corps rely on the visibility provided by program documentation to assess HSI performance, the Army's comprehensive documentation procedures affords a much broader view into program-level decision-making. However, such visibility is a dual-edged sword. While providing insight, it also provokes animosity among some program personnel who feel that their efforts are subjected to excessive scrutiny and/or unreasonable restrictions by external assessors. Resentment was especially vehement against those oversight authorities with little or no operational experience or accountability for the consequences of their assessments. Tellingly, one PM states that his second ignominious principle of program management is that "while the PM is chartered as the sole responsible program official, there is virtually no accountability for anyone else who sees fit to challenge his program anywhere, at any time."

Marine Corps HSI oversight capabilities, on the other

hand, are hindered by the narrow window of visibility provided by program documentation. Unless actively involved in the acquisition process by the PMO, the Program Support Directorate cannot fully evaluate a program's HSI effort, but rather is limited to reviewing HSI documentation for proper form and content. Marine Corps procedures currently do not evaluate the six HSI disciplines as an integrated entity. Instead, these disciplines are evaluated within various forums and at separate organizational levels. Even the performance of HSI analyses remain divided between two support agencies: the Training Systems Program Management Office retains cognizance over MPT analyses, while human factors engineering, system safety, and health hazards analysis are controlled by the Program Support
Directorate.

4. Forums

HSI forums are a fourth area in which the Army and Marine Corps differ. The Army addresses all six HSI disciplines in one forum, the MANPRINT Joint Working Groups. Organized at program initiation and meeting periodically thereafter, the MJWG provides an open forum specifically convened to identify, evaluate, and resolve human issues. The MJWGs were praised for their ability to communicate and integrate HSI issues between the PMO, the user proponent, HSI discipline representatives, system engineers, and the prime contractor.

The Marine Corps does not possess a standardized forum to address the integration of HSI issues. According to procedures established by the PMO, HSI concerns may be surfaced by discipline representatives attending either In-Process-Reviews or Integrated Logistics Support Management Team meetings. While both forums examine one or several of the HSI disciplines, neither specifically addresses all six disciplines in a consolidated manner.

By virtue of the Services' organizational size and

budgetary differences, the Army retains an elaborate HSI infra-structure compared to the Marine Corps' modest HSI support structure. However, both Services share their organizational resources through cooperative and contractual agreements. Thus, to varying degrees, the Army and Marine Corps can avail themselves to the same HSI support agencies. This includes the Army's extensive MANPRINT training program to which the Marine Corps is afforded access.

5. Commitment

The strength of the Marine Corps HSI program was demonstrated in the next area of contrast; commitment to the needs of the system operator and maintainer. The Marine Corps acquisition community possesses a strong organizational culture dedicated to satisfying the needs of the system operator and maintainer. This perspective appears to be based on the cyclical rotation of military acquisition practitioners between operational and acquisition tours of duty. The Army program offices displayed a similar, but less aggressive commitment to satisfying the users needs. However, the active participation of the user proponent, the TSM, and the assignment of MANPRINT Managers more than compensated for this imbalance.

While dedicated to the users needs, the Marine Corps exhibited less understanding and appreciation of HSI principles. Within the acquisition community confusion exists regarding HSI terminology and methodology. Because the HSI program was built on the foundation of the Navy's HARDMAN program, misunderstanding persists as to the roles and relationships of HSI, HARDMAN, and MANPRINT. Because of its historical bias, the HSI program continues to emphasize MPT issues with descending priority applied to human factors engineering, system safety, and health hazards.

Because of the institutionalization of the MANPRINT program, Army acquisition practitioners exhibited a sound

understanding and appreciation of HSI principles. Although less evident, some confusion does linger regarding the correlation between HSI and MANPRINT. Also a product of its historical foundations, the MANPRINT process demonstrated greater emphasis and proficiency in the disciplines of human factors engineering, system safety, and health hazards, and less in the MPT disciplines.

The Army and Marine Corps also diverged in the manner in which they achieved contractor commitment to HSI. The Marine Corps communicated its concern for the users needs through the personal dynamics of its PMO staff personnel. In the course of informal routine discussions, acquisition practitioners expressed their commitment to human issues and their expectations of the same from the contractors. In contrast, the Army formally required contractors to address human issues. Through the inclusion of MANPRINT as a separate major area in the source selection process and the delineation of program HSI deliverables, the Army contractually mandates contractor performance of HSI. Industry responded to both Services' HSI methodologies in a positive manner, adapting their practices to accommodate the Services' unique HSI requirements.

C. SUMMARY

In final analysis, the Army through its MANPRINT program successfully achieved the integration of human considerations into the acquisition process in accordance with the intent of DoD Instruction 5000.2. This objective was achieved through the systematic application of the following features of the MANPRINT program:

- The MANPRINT Joint Working Group comprised of HSI discipline representatives periodically assembled to surface, discuss, and formulate solutions to HSI concerns.
- A traceable audit trail to document and track HSI

issues from identification to resolution.

- The MANPRINT review and assessment process which evaluates the adequacy of HSI efforts and vertically integrates HSI issues within the Acquisition Command and Service.

- The inclusion of MANPRINT in the source selection process to contractually require contractor consideration of HSI issues throughout the design and development process.

Conversely, because of its current HSI practices, the Marine Corps has yet to fully integrate human considerations into the acquisition process. Although each program's HSI effort is unique and ultimately directed by the knowledge and initiative of the PMO staff, in general, Marine Corps programs, especially non-major programs, rely on "stove-piped" staffing of program documentation, rather than interactive forums, to accomplish HSI. Further, although human issues may be addressed within other forums, such as IPRs and ILSMT meetings, at no point in the acquisition process are representatives for all six of the HSI disciplines assembled to identify, debate, and synergistically formulate solutions to HSI trade-offs. Consequently, the Marine Corps, by acknowledging each discipline separately and not integrating their input to produce optimal system design solutions, may be inadvertently decreasing total system performance.

VIII. CONCLUSIONS AND RECOMMENDATIONS

A. OVERVIEW

Based on the conclusions derived from the comparative analysis performed in Chapter VII, this chapter addresses potential areas for organizational change within the Marine Corps Systems Command and proposes alternative solutions to enhance overall HSI effectiveness. The chapter will conclude with recommendations for areas of further study in the field of human systems integration.

B. CONCLUSIONS

1. Although in compliance with the requirements of DoD Instruction 5000.2, the Marine Corps HSI program does not possess policies or procedures to systematically integrate human issues into the material acquisition process. To date the Marine Corps has not established adequate Service or Acquisition Command policies or procedures for the systematic application, execution, or support of HSI. To achieve information exchange between HSI disciplines, the Marine Corps relies on "stove-piped" staffing of program documentation rather than standardized HSI forums.

Current practices fail to achieve the synergistic benefits incurred by an integrated approach to the evaluation of human issues during systems design. Consequently, the Marine Corps may be failing to optimize total system performance and/or minimize the cost of ownership of its acquisition programs. This situation is compounded for non-major programs which have commonly dedicated less effort to HSI despite significant levels of man-machine interface.

2. The effectiveness of the Marine Corps' HSI program is personality-dependent and driven by the operational expertise, acquisition experience, and personal initiative resident in the Program Management Office. Without standardized HSI policies or procedures, the Marine Corps

relies on the knowledge and initiative of its program management personnel to establish and execute HSI efforts. This practice results in the inconsistent application, performance, and support of HSI among the Marine Corps' acquisition programs. HSI variability exists not only between major and non-major programs, but between programs within the same acquisition category.

The consequences of such variability are lessened by the Marine Corps acquisition community's organizational culture which emphasizes the consideration of the system operator and maintainer during the acquisition cycle. Conscious of this institutional commitment, MARCORSYSCOM empowers its PMs to manage their HSI efforts with minimal bureaucratic direction or restraint. This commitment is nourished by the operational awareness brought to the acquisition process by military personnel rotating between operational and acquisition tours of duty. Further, it is communicated to industry on a routine basis through the personal dynamics of the PMO staff.

3. Current Marine Corps HSI practices and organizational relationships do not adequately involve the proponent of the system operator and maintainer in the HSI decision-making process. The user proponent, the MCCDC Requirements Officer, is granted limited visibility into the acquisition process. He is afforded visibility in three instances: 1) Milestone Reviews, 2) when a ORD threshold is to be breached, and 3) at the discretion of the PMO. Hence, the user proponent can only effectively influence system design through the requirements established within the ORD. Yet, under current procedures, human systems requirements are consolidated, rather than integrated, by staffing the ORD through the HSI disciplines for comment.

Lacking an involved or accountable advocate for the needs of the Marine end-user, other acquisition agencies have attempted to fill this role, specifically the Program Support

Directorate and the individual Program and Project Management Offices. While commendable, these initiates have further clouded the organizational understanding of the HSI roles and responsibilities within MARCORSYSCOM.

4. The Army MANPRINT program effectively fulfills the requirements of DoD Instruction 5000.2 through the establishment of an integrated and systematic approach to HSI. Army programs employing the MANPRINT process demonstrated consistently high levels of effectiveness in the application, performance, and support of HSI. Through the systematic implementation and integration of HSI analyses, these programs complied with both the requirements and intent of DoD's HSI policies.

By standardizing its MANPRINT policies and procedures, the Army successfully institutionalized a systematic approach to HSI, and thereby reduced HSI variability between acquisition programs. Army Regulation 602-2 clearly defines the roles and responsibilities of those organizations involve in the support, execution, or review of HSI. Although such polices lessen the autonomy of PMs to manage their programs, they provide effective Service-wide guidelines for the execution of HSI.

To ensure the effective integration of human issues into the material acquisition process, the MANPRINT program has implemented the following procedures:

- The organization of a structured forum, the MJWG, for the identification, discussion, and resolution of HSI issues;
- The establishment and maintenance of a traceable audit trail to document and track HSI issues throughout the acquisition cycle;
- The performance of an extensive HSI review and assessment process.

Through these practices, the MANPRINT program unifies and

strengthens the voice of the HSI disciplines within the system design and development process. Additionally, it capitalizes on the synergistic benefits incurred from the integrated evaluation of HSI issues, thereby optimizing total system performance and minimizing cost of ownership.

5. The strength of the MANPRINT program is the visibility it provides to human issues throughout the acquisition process, thereby allowing acquisition officials to make informed decisions regarding the needs of system users. The MANPRINT program provides senior acquisition officials excellent visibility into the program-level HSI decision-making process. Human issues are raised by the MJWG, documented and tracked by a traceable audit trail, reviewed and assessed by external HSI specialists, and then presented for consideration before Milestone Decision Authority. This methodology ensures that all human issues have at least been surfaced and considered during the acquisition cycle. Senior acquisition officials can subsequently review the HSI decision-making process and make informed decisions regarding the program's status.

6. The successful implementation of the MANPRINT program was founded on the ardent proponency of senior Army officials. The successful implementation of the MANPRINT program demonstrated that in order to institute and sustain an effective HSI program, the Service's senior military leaders must be steadfast in their commitment to its goals. To achieve Service-wide implementation, the MANPRINT program relied on a top-down management approach and the patronage of the Army's senior officials, specifically the DCSPER.

C. RECOMMENDATIONS

To improve the effective application, support, and performance of HSI throughout all Marine Corps acquisition programs, the following actions are recommended:

1. That the Marine Corps embrace the MANPRINT philosophy and tailor the MANPRINT program to the unique organizational environment of the Marine Corps acquisition process. As early as 1989, a British Army report foresaw the eventuality of this recommendation. In assessing the state of HSI with in the Department of Defense, the report stated:

> The other Services have human factors management programs which are less mature and perhaps less wide-ranging. It is possible that the USN and USAF will have to upgrade HARDMAN and IMPACTS, respectively to be more like MANPRINT. (Wolverson, 1989, p.3)

The effectiveness of the Marine Corps acquisition process in satisfying user needs could be significantly enhanced by the adoption of the MANPRINT philosophy. Such a philosophy would not only demonstrate the Service's commitment to the needs of the system operator and maintainer, but would improve its response to those needs by unify and strengthen the voice of the HSI disciplines in the acquisition process. The findings of this research indicate that while incurring short-term costs, the adoption of the MANPRINT philosophy would result in the optimization of total system performance and the minimization of system life-cycle costs.

To be effectively institutionalized, the MANPRINT philosophy would require the patronage of one or several senior Marine Corps acquisition officials, and the development of a top-down management plan. Subsequently, from this philosophical foundation, the Marine Corps can build a more effective HSI program. The Marine Corps should refrain from arbitrarily modeling its HSI program after the MANPRINT program. Instead, it should only select those MANPRINT policies, procedures, and practices deemed effective and suitable within the Marine Corps' unique organizational environment.

2. That MARCORSYSCOM develop formal policies and standardized procedures for the application, performance, and support of HSI for all acquisition programs. To consistently execute HSI effectively, MARCORSYSCOM should first expand its policies to more explicitly delineate the roles and responsibilities of those agencies involved in the performance, support, and oversight of HSI. Such policies should include formalize incentives to ensure the adequacy of program HSI efforts, and should promote the HSI training and education for all acquisition practitioners.

Secondly, the Command should establish systematic and standardized procedures for the application, execution, and support of HSI. Such procedures should guide the PM in the management of his HSI effort, and should be tailored to the unique aspects of each program.

3. That an HSI Section be established within MARCORSYSCOM to support Program Managers in the development, execution, and review of program-level HSI efforts. Through the consolidation and collocation of its HSI discipline representatives within one organization, MARCORSYSCOM could improve its ability to support and review HSI within its acquisition programs. An HSI Section, comprised of representatives of all six HSI disciplines, should be established within the Program Support Directorate.

The function of an HSI section would be twofold. The section's primary function would be to advise Program Managers and Project Officers. In this capacity, the section would assist in the development and execution of program HSI efforts, and evaluate the adequacy and accuracy of contracted HSI support. This function is increasingly important as schedule and budgetary constraints compel PMs to contract civilian contractors for more HSI analyses.

The HSI Section's secondary function would be to advise the PEO, through the Program Support Directorate, of the

status and adequacy of program HSI efforts. In this way, the HSI Section could share accountability for the efficient and effective performance of HSI. This recommendation would necessitate the transfer of the MPT LEMs from the Training Systems PMO to the Program Support Directorate. It would also eliminate the need for a MANPRINT Specialist billet within the Ground Weapons PMO staff.

4. That MARCORSYSCOM revise its oversight practices to increase visibility into the HSI decision-making process by: 1) requiring programs to maintain a traceable HSI audit trail, and 2) empowering HSI personnel, specifically represented by the Program Support Director, to more effectively evaluate program HSI efforts. To effectively manage its programs' HSI efforts, MARCORSYSCOM should increase visibility into the HSI decision-making process. To do so, MARCORSYSCOM should mandate and monitor program-level documentation of HSI considerations. Through the development and maintenance of the HSIP and other HSI documentation initiatives, such as an HSI Log, programs should be required to identify and subsequently track HSI issues, trade-offs, and decisions throughout the acquisition process. Improved HSI documentation procedures would:

- Establish a systematic method for acquisition programs to accurately track HSI issues from identification to resolution during the design and development process;
- Assure the PEO that human considerations have been raised and examined prior to granting Milestone Approval;
- Maintain communications with the user proponent as to the human issues involved with the system and the plans to address those concerns;
- Provide a source of HSI continuity to lessen the impact of personnel changes within the program or support offices;
- Reduce conflict with external oversight agencies by

providing evidence as to the extent and rationale of the HSI decision-making process;

- Improve the capability of internal oversight agencies to review and assess the status and adequacy of HSI efforts.

Further, MARCORSYSCOM should establish formal procedures for HSI reviews and assessments. As noted earlier, the purpose of HSI reviews would be to advise PMs in the development and direction of their HSI efforts. The purpose of the HSI assessments would be to advise the PEO as to the status and adequacy of the HSI efforts of the programs coming before Milestone Review. Such oversight should be performed by a consolidated HSI Section within the Program Support Directorate. To ensure consistency and increase effectiveness, the application and performance of HSI assessments should be proscribed by formal directive. Assessment procedures should stipulate that, from the outset of the acquisition cycle, PMs maintain a dialogue with HSI assessors regarding the program's significant human issues, trade-offs, and decisions.

5. That MARCORSYSCOM should establish an HSI working group specific to each program to identify HSI issues and trade-offs throughout acquisition cycle. At Milestone 0, a MCCDC Requirements Officer, in coordination with MARCORSYSCOM, should convene and chair an HSI Working Group (HSIWG) to address, support, and review the HSI concerns of designated acquisition programs. Upon appointment of a PM, MARCORSYSCOM would assume management responsibilities for HSI and chair the HSIWG. To inform and involve the user proponent in the HSI decision-making process, the Requirements Officer would remain a member of the HSIWG throughout the acquisition cycle. The membership of the HSIWG should be tailored to based on the human performance issues of the system. A standard HSIWG should be comprised of the following members:

- PMO Representative - Chairman
- Contractor HSI Manager - Vice Chairman
- MCCDC Program Action Officer
- Manpower, Personnel, and Training Representative
- Human Factors Engineer
- System Safety/Health Hazards Engineer
- Other HSI Support Agency Representatives

Meeting on a periodic basis throughout the acquisition process, the HSIWG, using its collective expertise, would be responsible for developing and maintaining the HSIP. The HSIWG would determine the level of HSI involvement for each system. Finally and most importantly, the HSIWG would ensure that identified issues are communicated to other acquisition organizations and are included in the requirement, program, and solicitation documentation. Through the HSIWG, the Marine Corps would achieve the effective integration of human issues into the material acquisition process, in accordance with the intent of DoD Instruction 5000.2.

6. That through the inclusion of HSI as a separate major area in the source selection process, MARCORSYSCOM require Contractors to address HSI issues throughout system design and development. HSI should be included as a separate major area of the same visibility as technical, management and cost in the source selection process. By doing so, the Marine Corps can communicate to industry the value it places on the consideration of human issues in the acquisition cycle. Through the establishment of contractual obligations and program deliverables, the Marine Corps can lessen its reliance on the personal dynamics of the PMO staff, and thereby reduce HSI performance variability between acquisition programs.

7. That in its on-going acquisition reform efforts, the

Office of the Secretary of Defense should better articulate the purpose and procedures of human systems integration. In future publications, OSD should clarify the intent of its HSI policies to ensure that integration is being achieved. To eliminate confusion, OSD should also endeavor to establish throughout the Department of Defense commonality of HSI terminology.

D. AREAS FOR FURTHER STUDY

During the course of this research, other areas which appear to merit additional study were identified. These topics were beyond the scope of this thesis, but are presented here for further consideration and potential research.

1. Comparative analysis of current human systems integration methodologies in the acquisition of automated information systems (AIS). Whereas this thesis focused exclusively on the material acquisition process, limited research has been conducted on the application of HSI methodologies in automated information systems (AIS) acquisition. In recent years, the Army MANPRINT program has expanded to include the analysis of human issues in the development of AIS. Future research should address the effectiveness of MANPRINT AIS procedures and their applicability to the Marine Corps systems acquisition process.

2. Analysis of the effects of current Naval human system integration policies and procedures on the procurement of Marine Corps aviation systems and equipment. Since Marine Corps aviation systems and equipment are procured under the guidance of the Naval Air Warfare Systems Command, future research should evaluate the effectiveness of NAVAIR's HSI policies and procedures. Such research should examine the use of NAVAIR models and simulation techniques to address Marine Corps unique HSI issues.

3. Comparative cost and operational effectiveness

analysis (COEA) of Marine Corps human systems integration support sources. Further investigation is required into the cost effectiveness of alternative approaches for sourcing of HSI support within MARCORSYSCOM. The research should examine the cost effectiveness of both in-house and contracted HSI support services, as well as various combinations thereof.

4. Reverse engineering analysis of fielded Marine Corps material systems to quantify the life-cycle cost ramifications incurred by the inclusion of human systems integration in the acquisition cycle. To justify further investment of Marine Corps resources, research should be conducted to quantify the system life-cycle costs incurred by the performance or absence of HSI. Following the Army's example, the investigation should identify the manpower, personnel, training, safety, and health hazard costs incurred by systems fielded with limited or no HSI.

APPENDIX A. HUMAN SYSTEMS INTEGRATION ATTRIBUTES MATRIX

HUMAN SYSTEMS INTEGRATION ATTRIBUTES MATRIX (HSIAM)

		Points Awarded By Attribute				Percentage of Total By Attribute			
		Marine Corps		Army		Marine Corps		Army	
HSI Attributes	Weights	AAAV	SRAW	AGS	AAWS-M	AAAV	SRAW	AGS	AAWS-M
A. ORGANIZATIONAL POLICY									
1. Does the Service or Acquisition Command support the performance of HSI?	5%	6	5	9	8	3.0	2.5	4.5	4.0
2. Do Service or Acquisition Command policies clearly designate HSI roles and responsibilities?	4%	4	3	8	8	1.6	1.2	3.2	3.2
3. Do systematic procedures exist within the Service or Acquisition Command to perform/support HSI?	3%	4	3	9	8	1.2	0.9	2.7	2.4
4. Do incentives exist within the Service or Acquisition Command to promote HSI?	3%	5	4	8	7	1.5	1.2	2.4	2.1
5. Do Service or Acquisition Command HSI policies strengthen the authority of the Program Manager to efficiently mange his program?	5%	8	9	4	4	4.0	4.5	2.0	2.0
CATEGORY TOTAL	**20%**	**27**	**24**	**38**	**35**	**11.3**	**10.3**	**14.8**	**13.7**
B. ORGANIZATIONAL OVERSIGHT									
6. Is the proponent for the system operator and maintainer effectively involved (visible) in the acquisition decision-making process?	4%	4	3	9	8	1.6	1.2	3.6	3.2
7. Are HSI trade-offs made during the acquisition process documented by a traceable audit trail?	4%	4	2	9	8	1.6	0.8	3.6	3.2
8. How effective is the Service or Acquisition Command's HSI review (assessment) process in identifying and evaluating HSI issues?	4%	6	5	8	7	2.4	2.0	3.2	2.8
9. Do adequate procedures exist to enforce the correction of HSI concerns?	4%	5	5	8	7	2.0	2.0	3.2	2.8
10. Are adequate feedback mechanisms employed to evaluate the effectiveness of HSI efforts during the acquisition cycle?	4%	6	5	7	6	2.4	2.0	2.8	2.4
CATEGORY TOTAL	**20%**	**25**	**20**	**41**	**36**	**10.0**	**8.0**	**16.4**	**14.4**
C. ORGANIZATIONAL SUPPORT									
11. Does the Service or Acquisition Command possess agencies capable of supporting HSI analyses?	6%	4	5	8	8	2.4	3.0	4.8	4.8
12. Do effective forums exist to allow for system trade-offs between HSI disciplines to be identified?	5%	5	3	9	9	2.5	1.5	4.5	4.5
13. Are HSI support organizations involved early enough in the acquisition cycle to effectively influence system design?	5%	4	3	8	8	2.0	1.5	4.0	4.0
14. Does the Service or Acquisition Command educate Program Management personnel on HSI policies or procedures?	4%	4	4	6	7	1.6	1.6	2.4	2.8
CATEGORY TOTAL	**20%**	**17**	**15**	**31**	**32**	**8.5**	**7.6**	**15.7**	**16.1**

HUMAN SYSTEMS INTEGRATION ATTRIBUTES MATRIX (HSIAM)

HSI Attributes	Weights	Points Awarded By Attribute				Percentage of Total By Attribute			
		Marine Corps		Army		Marine Corps		Army	
		AAAV	SRAW	AGS	AAWS-M	AAAV	SRAW	AGS	AAWS-M
D. PROGRAM APPLICATION									
15. To what degree did the Program Management Office display commitment to satisfying the needs of the system operators and maintainers?	6%	9	8	6	6	5.4	4.8	3.6	3.6
16. Did the Program Management Office demonstrate understanding of HSI principles?	5%	7	4	8	8	3.5	2.0	4.0	4.0
17. Was a member(s) of the Program Management Office specifically tasked with management of HSI?	2%	7	4	9	7	1.4	0.8	1.8	1.4
18. To what extent was the HSI Manager trained or educated in the performance of HSI?	2%	7	3	6	7	1.4	0.6	1.2	1.4
19. Was a Human Systems Integration Plan developed for the program in accordance with DoD Inst 5000.2?	3%	6	1	8	8	1.8	0.3	2.4	2.4
20. Did Program documentation, to include the HSIP, adequately address the following HSI disciplines?									
20.a. Manpower	2%	7	6	6	7	1.4	1.2	1.2	1.4
20.b. Personnel	2%	7	6	6	7	1.4	1.2	1.2	1.4
20.c. Training	2%	7	7	7	6	1.4	1.4	1.4	1.2
20.d. Human Factors Engineering	2%	5	5	7	8	1.0	1.0	1.4	1.6
20.e. System Safety	2%	4	4	8	7	0.8	0.8	1.6	1.4
20.f. Health Hazards	2%	4	4	8	7	0.8	0.8	1.6	1.4
21. Were human considerations effectively integrated between and among HSI discipline support agencies?	4%	4	3	9	9	1.6	1.2	3.6	3.6
22. Were HSI considerations included as evaluation criteria during source selection?	3%	5	2	9	6	1.5	0.6	2.7	1.8
23. To what degree did the Contractor(s) demonstrate commitment to the HSI effort?	3%	7	5	9	7	2.1	1.5	2.7	2.1
CATEGORY TOTAL	**40%**	**86**	**62**	**106**	**100**	**25.5**	**18.2**	**30.4**	**28.7**
TOTAL PROGRAM EFFECTIVENESS	**100%**	**155**	**121**	**216**	**203**	**55.3**	**44.1**	**77.3**	**72.9**
MARINE CORPS HSI PROGRAM EFFECTIVENESS	**Points Awarded**		**138**		**Compliance Percentage**			**49.7**	
ARMY MANPRINT PROGRAM EFFECTIVENESS			**210**					**75.1**	

APPENDIX B. ORGANIZATIONS VISITED OR CONTACTED

1. OFFICE OF THE SECRETARY OF DEFENSE

Assistant Secretary of Defense (Personnel and Readiness), Human Systems Integration Division, Washington, D.C.

2. DEPARTMENT OF THE NAVY

Chief of Naval Operations, Training Requirements, Acquisition, and Technical Policy Branch (N71D), Washington, D.C.

Naval Postgraduate School, Monterey, CA
- Operations Research Department
- Systems Management Department

3. UNITED STATES MARINE CORPS

Marine Corps Combat Development Command, Quantico, VA
- Requirements Division
- Training and Education Division

Marine Corps Systems Command, Quantico, VA
- Program Analysis and Evaluation Directorate
- Program Support Directorate
- Program Management Office, Ground Weapons
  - Assistant Program Management Office, Anti-Armor Weapons
- Program Management Office, Training Systems
  - Manpower and Training Branch

Direct Reporting Program Manager, Advanced Amphibious Assault Vehicle, Clarendon, VA

4. DEPARTMENT OF THE ARMY

Deputy Chief of Staff for Personnel, Washington, D.C.
- MANPRINT Directorate

Deputy Chief of Staff for Operations and Plans, Washington D.C.

Deputy Chief of Staff for Plans, Force Integration, and Analysis, Total Army Personnel Command, Alexandria, VA
- MANPRINT Division

Program Executive Officer for Fire Support
Project Office, Advanced Anti-tank Weapons System - Medium, Redstone Arsenal, AL

Program Management Office, Armored Gun System, Warren, MI

5. **NON-DOD ORGANIZATIONS**

United Defense, Limited Partnership, Santa Clara, CA

APPENDIX C. TERMINOLOGY

HUMAN SYSTEM INTEGRATION TERMINOLOGY

A. HUMAN FACTORS

1. Definition:

A body of scientific information about human characteristics. The term covers all biomedical and psychosocial considerations; it includes but is not limited to, principles and applications in the areas of human engineering, personnel selection, training, life support, job performance aids, and human performance evaluation. (DODDIR 5000.2; 23 FEB 91, P. 15-7)

B. HUMAN ENGINEERING

1. Definition:

The application of available knowledge which defines the nature and limits of human capabilities as they relate to the check-out, operation, maintenance or control of systems or equipment, and which may be applied during engineering design to achieve optimum compatibility between equipment and human performance. (MIL-STD-1472C; p. 8)

2. Topical Areas:

- Human physical and mental capabilities and limitations.
  (a) Abilities, skills, knowledge, and aptitudes
  (b) Skill acquisition
  (c) Skill perishability
- Human-machine interface.
- Anthropometric and biomedical criteria
- Mission function and human requirements analysis
- Performance under stress
- Performance Assessment

C. MANPOWER AND PERSONNEL

1. Definition:

The identification and acquisition of military and civilian personnel with the skills and grades required to operate and support a material system over its lifetime at peacetime and wartime rates. (DODDIR 5000.2; p. 15-7)

2. Topical Areas:

- Personnel selection and classification
- Demographics
- Rates
  (a) Accession rates
  (b) Attrition rates
  (c) Retention rates
  (d) Training rates
- Force structure
- Manning concepts
  (a) Automation
  (b) Robotics

D. TRAINING AND TRAINING SUPPORT

1. Definition:

The processes, procedures, techniques, training devices, and equipment used to train civilian and active duty and reserve military personnel to operate and support a material system. This include individual and crew training; new equipment training; initial formal, and on-the-job training; and logistic support planning for training equipment and training device acquisitions and installations. (DODDIR 5000.2; p. 15-8)

2. Topical Areas:

- Training concepts and strategy
- Task analysis methods
- Media/equipment selection
- Simulation

- Training system evaluation
- Training development plan

E. SYSTEM SAFETY

1. Definition:

The application of engineering and management principles, criteria, and techniques to optimize safety within the constraints of operational effectiveness, time, and cost throughout all phases of the system life-cycle. (DODDIR 5000.2; p. 15-16)

2. Topical Areas:

- Lessons learned
- Human error
- Environmental considerations
- Protective equipment

APPENDIX D. LIST OF ABBREVIATIONS AND ACRONYMS

AAA	Advanced Amphibious Assault
AAAV	Advanced Amphibious Assault Vehicle
AAE	Army Acquisition Executive
AAWS-M	Advanced Anti-tank Weapon System (Javelin)
ACAT	Acquisition Category
ADM	Acquisition Decision Memorandum
AGS	Armored Gun System
ACMC	Assistant Commandant of the Marine Corps
AMC	Army Material Command
ARI	Army Research Institute
ARL	Army Research Laboratory
ASAP	Army Streamlined Acquisition Process
ASARC	Army Systems Acquisition Review Council
ASARDA	Assistant Secretary of the Army, Research, Development, and Acquisition
ASN, RD&A	Assistant Secretary of the Navy, Research, Development and Acquisition
CCVL	Close Combat Vehicle-Light
CDP	Combat Development Process
CE/D	Concept Exploration and Development
CG	Commanding General
CHRT	Coordinated Human Resource Technology
CLU	Command Launch Unit
CMC	Commandant of the Marine Corps
CNO	Chief of Naval Operations
COEA	Cost and Operational Effectiveness Analysis
DAB	Defense Acquisition Board
DCS, M&RA	Deputy Chief of Staff, Manpower and Reserve Affairs
DCSPER	Deputy Chief of Staff for Personnel
DID	Data Item Description
DOD	Department of Defense
DODD	DOD Directive
DODI	DOD Instruction
DSMC	Defense Systems Management College
D&V	Demonstration and Validation
EMD	Engineering and Manufacturing Development
EOA	Early Operational Assessments
FMF	Fleet Marine Force
GAO	General Accounting Office
HARDMAN	Hardware Procurement and Military Manpower
HEL	Human Engineering Laboratory
HIP	Howitzer Improvement Plan
HQ	Headquarters
HQDA	Headquarters, Department of the Army
HQMC	Headquarters, Marine Corps
HRED	Human Research Engineering Directorate
HSI	Human Systems Integration

HSIP	Human Systems Integration Plan
IG	Inspector General
ILS	Integrated Logistics Support
ILSM	ILS Manager
ILSMT	ILS Management Team
IMPACTS	Improved Manpower, Personnel, and Comprehensive Training and Safety
IPR	In Process Review
LAR	Logistics Assessment Review
LCC	Life-cycle cost
LEM	Logistical Engineering Manager
LHX	Light Helicopter Experimental
LRG	Logistics Review Group
LVAD	Low Velocity Air Drop
MAA	Mission Area Analysis
MACOM	Major Army Command
MANPRINT	Manpower and Personnel Integration
MARCORSYSCOM	Marine Corps Systems Command
MCCDC	Marine Corps Combat Development Center
MCPDM	Marine Corps Program Decision Memorandum
MCRDAC	Marine Corps Research, Development and Acquisition Command
MCO	Marine Corps Order
MCRDAC	Marine Corps Research, Development and Acquisition Command
MCTSSA	Marine Corps Tactical Systems Support Activity
MER	Manpower Estimate Report
MJWG	MANPRINT Joint Working Group
MMT	MANPRINT Management Team
MNS	Mission Needs Statement
MOA	Memorandum of Agreement
MOPP	Mission Oriented Protective Posture
MOS	Military Occupational Specialty
MPTS	Manpower, Personnel, Training and Safety
MTT	Mobile Training Team
MTTR	Mean-Time-To-Repair
NAVAIR	Naval Air Systems Command
NAVSEA	Naval Sea Systems Command
NAWCTSD	Naval Air Warfare Center
NDI	Non-Developmental Item
O&S	Operations and Support
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
OTH	Over-the-Horizon
PA&E	Program Analysis and Evaluation
P&D	Production and Development
PEO	Program Executive Office
PM	Program/Project/Product Manager
PMO	Program Management Office
PMS	Pedestal Mounted Stinger (Avenger)
PO	Project Officer

POA&M	Program of Action and Milestones
PS	Program Support Directorate
R&D	Research and Development
RFP	Request For Proposal
ROC	Required Operational Capability
SECDEF	Secretary of Defense
SECNAV	Secretary of the Navy
SECNAVINST	Secretary of the Navy Instruction
SES	Senior Executive Service
SMAW	Shoulder-Launched Multipurpose Assault Weapon
SMMP	System MANPRINT Management Plan
SPAWAR	Naval Space Command
SRAW	Short-Range Anti-Tank Weapon (Predator)
STRAP	System Training Plan
TIWG	Test Integration Working Group
TRADOC	Training and Doctrine Command
TRPPM	Training Planning Process Methodology
TSM	TRADOC System Manager
USMC	United States Marine Corps
WSAP	Weapon Systems Acquisition Process

APPENDIX E. HUMAN SYSTEMS INTEGRATION PLAN FORMAT

HUMAN SYSTEMS INTEGRATION PLAN
FOR
(PROGRAM TITLE)

1. Executive Summary.

Provide in the executive summary an overview of the Human Systems Integration (HSI) strategy. Present a description Of the highlights of the Human Systems Integration Plan (HSIP). Describe how HSI objectives and requirements contribute to readiness, force structure, affordability, performance effectiveness, and achievement of wartime operational objectives. Describe the scope and purpose of the HSIP. Summarize HSI constraints and results of HSI analyses and trade-offs.

2. Introduction.

Provide the objectives and scope of the HSIP. Introduce the HSIP briefly, describing what is contained in the body of the plan. Address the requirements for tailoring HSIP requirements.

3. System Description.

Provide general descriptions of the system itself; major system components including form, fit and function; missions to be performed; operational and maintenance environments; alternative concepts or designs; and essential total system (human-in-the-loop) performance characteristics and techniques for integrating humans into the system. Describe the performance goals and thresholds which require HSI-related design interface and support analysis. Describe the stage of system development at the time of HSIP publication. The level of detail should be consistent with the maturity of the system development.

A. Acquisition strategy Summary: Summarize the proposed or approved strategy including the determination that the acquisition is a new development, Mil-Spec procurement, NonDevelopment Item (NDI), or a Product Improvement (PI).

B. Activities involved. Identify the lead acquisition agent, sponsor and all other major commands involved. Provide a complete list of all commands and activities concerned with HSI in Annex A.

C. System acquisition milestones and schedule. List dates for key events linked to the HSI Milestone Schedule contained in Annex B.

D. Guidance. Describe prior decisions, general DON guidance, assumptions, mandated constraints, and information pertaining to personnel characteristics and force structure.

4. HSI Issues and Constraints.

Identify key issues that have HSI implications, including constraints established in the Mission Need Statement (MNS). Include major design, readiness, test and evaluation, and affordability issues.

A. Manpower issues and constraints. Provide end strength limitations; budget limitations; demographic limitations; requirements for reduced manning; constraints on crew size and mix.

B. Manpower Availability. Provide personnel availability estimates by skill level and source.

C. Human capability/training issues and constraints. Provide minimum skill level projection; constraints on personnel progression; constraints on training equipment and facilities; requirements for special skills and cross training, embedded training, training devices and training media.

D. Human performance issues and constraints. Identify critical error types, establish performance standards and determine effects of automation on human skills and performance, team performance requirements; human performance limitations and capabilities as a function of proposed human-system interfaces (e.g., the effects and interaction of human fatigue and Nuclear, Biological and Chemical (NBC) protective equipment on human performance, system design and manpower).

E. System safety, health, and environmental issues and constraints. Identify system safety, health, and environmental issues, limits to be placed on environmental factors, biomedical and habitability constraints, and planning for human mishap prevention.

5. HSI Program

A. HSI Objectives. Identify HSI objectives to be achieved during the acquisition process, including specifics for each domain .

Examples are:

(1) Reductions in manpower positions or requirements resulting from automation, design improvements, or cross-training with numbers of required billets expressed either in absolute quantitative/qualitative terms or as compared with the predecessor system.

(2) No increase in the characteristics and skills of operators, maintainers, or supporters; quantitative goals for personnel capabilities.

(3) No increase in training hours from the predecessor system; use of advanced training technology or techniques (e.g., embedded training, intelligent tutoring, or interactive courseware training systems).

(4) Establishment of a Human Factors Engineering (HFE) program.

(5) Establishment of system safety and health hazard control programs.

B. HSI Strategy. Present the HSI strategy reflecting the system acquisition strategy and addressing HSI risk assessment and reduction, application of advanced technology in the achievement of HSI objectives, reliance on commercial standards and data (e.g., American Society for Testing Materials (ASTM) or American National Standards Institute (ANSI)), establishment of HSI priorities, and a description of the process to be implemented to ensure that HSI objectives are met. Describe the approach for addressing HSI issues throughout the acquisition process.

C. HSI Analyses. Identify analyses to be conducted, and their effects on managing HSI risks. Refer to Annex C for data sources. Analyses will include HARDMAN methodology, including analysis of predecessor systems, and development of human factors engineering analysis (MIL-H-46855), system safety programs, and could involve a task analysis.

D. HSI Analyses Results: Impacts on Design and Risks. For each alternative concept or design, provide a summary of the results of Manpower, Personnel and Training (MPT), Human Factors Engineering (HFE), Systems Safety (SS), Health Hazards (HH) and other analyses such as those accomplished for the Cost and Operational Effectiveness Analysis (COEA), Program Life-Cycle Cost (LCC) Estimate, etc.
   (1) Critical Human System Factors.
   (2) Manpower Impact. Also, identify net manpower requirements by quantity and quality.
   (3) Personnel Impact. Also, identify new occupational specialties requirements by Rank/Rating/Naval Officer Billet Classification (NOBC)/Military Occupation Specialty (MOS).
   (4) Human Factors Engineering.
   (5) Safety and Health Hazards. Also, include LCC estimates such as the cost of acquiring, handling, using and disposing of hazardous materials.
   (6) Training Requirements. Also, describe the training concept including types of training required and potential locations; identify the cost of high driver training resource requirements such as technical training equipment, training devices, military construction and lengthy course development.
   (7) Unit Readiness.
   (8) Trade-off Analysis.

E. HSI Test and Evaluation. Describe how the system Test and Evaluation (T&E) program will assess HSI domains in each phase of the acquisition process.

F. HSI Relationships. Define how HSI is organized within the acquisition program and how HSI will interact with the ILS and system engineering design programs. Address specific program relationships among the HSI domains (i.e., HFE, MPT, SS and HH).

6. HSI Activities.

Develop a tailored listing of all HSI activities. Describe in this paragraph the HSI activities by acquisition phase in terms of task, required resources, time to complete, responsible organization, support organizations and activity dependencies.

Index of Annexes to the HSI Plan

Annex A. HSI Points of Contact

Annex B. HSI Milestone Schedule

Annex C. References and Data Sources

Annex D. HSI Issues

Annex E. HSI History

Annex A. HSI Points of Contact

List of organizational activities needed for HSI information and assistance. Include the organizational activities identified in paragraph 3b and those activities responsible for the tasks included in the HSI Milestone Schedule, Annex B, of the HSIP.

Annex B. HSI Milestone Schedule

Display HSI tasks with schedule relationships to the acquisition, budgeting, and funding processes.

Annex C. References and Data Sources

Provide references and data sources used for the HSI effort. Examples include acquisition documents (Mission Need Statement (MNS), Operational Requirements Document (ORD), Integrated Program Summary (IPS)), T&E documentation, HSI data, predecessor and comparable system analyses and new technology descriptions.

Annex D. HSI Issues

Provide a list of issues that will influence HSI decisions. Describe issue, responsible activity, proposed resolution date, and status.

Annex E. HSI History

Discuss program decisions and events that have affected HSI.

APPENDIX F. SYSTEM MANPRINT MANAGEMENT PLAN FORMAT

SYSTEM MANPRINT MANAGEMENT PLAN
FOR
(PROGRAM TITLE)

1. Executive summary
Provides an overview of the MANPRINT strategy to be employed and the highlights of the SMMP.

2. System description

A. Description of the proposed material system. Provide an overview including, but not limited to, the material deficiency being addressed, missions, operational environments, design versions or alternatives, and essential total system (soldier-in-the-loop) performance characteristics.

B. Acquisition strategy. Briefly discuss the life-cycle system management model strategy to be employed and how it will impact the MANPRINT effort.

C. Agencies. List the lead agency and all agencies expected to be involved in supporting the system acquisition.

D. Guidance.

(1) Decisions. List all decisions that will have a direct impact on the design and/or MANPRINT issues.

(2) General Department of the Army and Material Command guidance. List all available guidance provided for MANPRINT issues.

(3) Assumptions. List all assumptions, not provided in guidance, that will have a direct impact on the design and/or MANPRINT issues.

3. MANPRINT strategy

A. Goals. Identify the MANPRINT goals to be achieved during the acquisition process.

B. Data sources and availability.

(1) Predecessor system. Determine the predecessor or reference systems and components, if any. Consider predecessors for each component of the material system, training devices, and repair and support equipment.

(2) Early availability of data and risk analysis. Discuss the types and importance of data and when it is to be available for inclusion in analyses. Determine its impact on the MANPRINT strategy to be employed and the associated level of risk incurred. Provide the rationale

and background employed in deciding how to address MANPRINT issues throughout the acquisition life-cycle.

(3) Planned level of MANPRINT analysis effort. Identify what and when analyses are to be conducted based on the availability of data and resources. Include how they will affect the risk incurred by the MANPRINT strategy employed.

(4) Baseline MOS description. Describe the quantity, quality, and performance of soldiers and civilians who operate, maintain, and support the predecessor system. Indicate how these characteristics relate to performance of operational, maintenance, and support tasks associated with the predecessor system.

4. Critical issues

List and discuss the major risk areas that, if unresolved, will cause the program to be modified. Each challenge will have at least one associated MANPRINT concern (see Tab D).

5. Tabs

A. Tab A - Data Sources. List all potential data sources, the MANPRINT areas (manpower, personnel, training, human factors, system safety, and health hazards) addressed and the data item's relative importance to the system's development. This will form the cornerstone for all analyses and planning.

B. Tab B - System and MANPRINT Milestone Schedule. Using the Gantt Chart format, display all significant problem milestones (Milestone Decision Reviews, design reviews, etc.) and MANPRINT tasks to be accomplished from research and exploratory development through first unit equipped.

C. Tab C - Task Description. For each task to be performed list the following information (necessary for Tab B preparation):

(1) Task description (narrative).
(2) Rationale (why is it necessary).
(3) Resources (personnel and dollars).
(4) Time to complete (optimistic, normal, pessimistic).
(5) Responsible agency (lead agency).
(6) Support agencies.
(7) Dependencies (tasks that must be completed prior to this one or required data during the execution of this task).
(8) Feeds (tasks that cannot start until this one has been completed or use data from this task while they are in process).

D. Tab D - MANPRINT Major Issues/Concerns. Use a separate sheet for each issue or concern. Record the background, planned solution, and current status of each issue, concern, or tracking list item. Update each sheet periodically. When the issue or concern is resolved, update the sheet to show that the item is closed, and record the necessary entry in Tab F - Audit Trail.

E. Tab E - Coordination. List all commands, agencies, and activities with whom the SMMP must be coordinated.

F. Tab F - Audit Trail. Document significant MANPRINT related decisions made during the entire system's life.

G. Tab G - Target Audience Description. Identify likely characteristics of personnel for whom the new material or equipment is being developed or acquired. Describe the range of individual qualifications and relevant dimensions of the proposed operators and maintainers.

H. Tab H - Lessons Learned and Deficiencies of Predecessor System. Identify, by domain, major lessons learned and deficiencies which have been identified from all applicable predecessor systems.

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Training Systems
Code SST
2033 Barnett Avenue
Quantico, Virginia 22134-5010 — 1

10. Director
MANPRINT Directorate
Office of the Deputy Chief of Staff
for Personnel
Headquarters, Department of the Army
Washington, D.C. 20310-0300 — 2

11. Captain Michael F. Belcher
1922 Oakwood Street
Temple Hills, Maryland 20748 — 2